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THE BENDING OF RAILS IN THE TRACK by locomotives with faulty counterbalancing has recently been discovered on the Louisville & Nashville R. R. The rails were bent sidewise and not vertically, as is usually the case when the counterbalance is too heavy, and there seemed to be no bending action produced by the driving wheels until the speed was over 48 miles an hour. The bends were produced first at one side and then at the other, evidently by alternate blows from the sides of driving wheels. It was found that the main driving wheels were about 600 lbs. short of the correct weight for counterbalance, and this weight was distributed between the back and front wheels of the engine. This caused an oscillating motion, and the driving wheels rocked from side to side. By using lead, the proper weight was put into the main driving wheels, and the extra weight was then taken out of the other wheels. This resulted in stopping the evil effect upon the track.

SOME TWO-CYLINDER COMPOUND LOCOMOTIVES, of the consolidation type, have been built by the Pittsburg Locomotive Works, of Pittsburg, Pa., for the Lake Superior & Ishpeming Ry. The compounding system adopted by the Pittsburg Locomotive Works was described in our issue of Jan. 2, 1896, and the following are the dimensions of these new engines:

Driving wheels, diameter	4 ft. 8 ins.
Driving-wheel journals	8 × 9 "
Wheelbase, driving	15 ft. 6 "
" total engine	23 " 6 "
" engine and tender	15 ft. 10½ "
Weight on driving wheels	132,800 lbs.
" total, engine	147,600 "
" of tender, loaded	76,200 "
Cylinders, h. p.	20 × 28 ins.
" l. p.	31 × 28 "
Boiler, straight, diameter	5 ft. 7 "
Boiler pressure	180 lbs.
Tubes, 240; diam. 2¼ ins.; length	14 ft. 7 ins.
Firebox	9 ft. 0 ins × 3 ft. 6⅜ "
Grate area	31.78 sq. ft.
Heating surface, tubes	2,049.50 " "
" " firebox	148.60 " "
" " total	2,198.10 " "
Height, rail to smokestack	14 ft. 11¼ ins.
Coal capacity of tender	280 cu. ft.
Water capacity of tender tank	4,000 gallons.
Fuel	Bituminous coal.
Brake fittings	Westinghouse-American automatic.

RECORDING TURNSTILES are being tried at some of the less important stations of the New York elevated railways, to avoid the expense for tickets, ticket sellers and ticket choppers. One man takes the fares and releases the clutch of the machine, allowing the arms to revolve as the passenger pushes against them. The machine is locked at each quarter of a revolution and registers the number of revolutions. The machines have been in use on the Brooklyn Elevated R. R. for some time. They are manufactured by the American Passimeter Co.

THE KINGS COUNTY ELEVATED RY. CO., of Brooklyn, N. Y., was placed in the hands of a receiver on Aug. 31, Gen. James Jourdan, the President of the company, being appointed to that office by general consent. This road was chartered in January, 1879, but owing to litigation construction was not commenced until 1886, and the first three miles of the railway were opened to traffic on April 24, 1888. On Aug. 20, of the same year, 4½ miles were in operation. The Fulton Elevated Ry. Co. was then organized to extend the road to Jamaica, and it was leased to the Kings County Co. for 99 years and completed in July, 1894. In 1895 the company was reorganized, absorbing the Fulton elevated railway, and its capital stock was increased from $3,250,000 to $4,750,000; both first and second mortgage bonds were issued at the rate of $550,000 per mile of road. The Brooklyn & Brighton Beach Railway was leased in December 1895. The cause given for the failure is the great decrease in revenue due to the competition of the trolley surface roads.

ELECTRIC TRACTION on the Nantasket Beach Branch of the New York, New Haven & Hartford R. R. was in June last extended as far as East Weymouth in the direction of Boston, on the main line of the Old Colony Division. On the new line, however, the overhead conductor is not used. A third rail laid between the rails of the surface track takes the place of the trolley wire, and the cars have been regularly operated over it between the regular steam trains without hitch or difficulty. In the operation of the cars the change from the overhead trolley to the third rail source of power is made imperceptibly. When the car approaches the end of the trolley wire a knife switch under the hood of the car is closed connecting the shoe beneath the car with the motor circuit; the trolley slides off the overhead wire and is hooked down, the car meanwhile continuing on its journey. On the day of the inauguration of the third rail section several high speed spurts were made, and these have frequently been exceeded in the actual service. The first section, with overhead trolley wire, was described and illustrated in our issue of Aug. 1, 1895. The overhead wire and third rail sections were both built by the General Electric Co. The car house has four pits over which the cars may be run for examination of the motors and is fully equipped with all the necessary appliances.

IRON CAR-TRANSFER BRIDGES are being placed at certain points along the water front of Brooklyn, N. Y., in connection with the new dock railway system of the Brooklyn Wharf & Warehouse Co. Each transfer bridge has two through trusses, 100 ft. long, 33 ft. wide and 9 ft. deep, and weighs about 120 tons. The river end will be supported by a wooden pontoon, 40 × 30 ft., 7 ft. deep. The bridges are built on the ground by the Elmira Bridge Co., of Elmira, N. Y.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was the derailment of the southbound White Mountain express, of the Boston & Maine R. R. at Concord N. H., Aug. 27. The train was entering the yard at a speed of about 30 miles an hour when it was derailed by a defective switch, the engine and tender were upset and fell over on their sides, and the heavy baggage car telescoped the smoking car for half its length. None of the other cars were badly damaged. Nobody was killed outright, but fifteen persons were injured, some seriously. ——A rear collision between a westbound special freight train and a newspaper express occurred Aug. 30 at Orange, Mass., on the Fitchburg R. R. The freight train was ahead, but had broken apart while east of Orange, and as the delay made it impossible to reach Erving, where it had orders to let the express pass, the train was trying to reach Orange to cross over to the eastbound track. It did not reach the crossover in time to avoid the collision. The engine of the express smashed and derailed twelve cars and then left the track and fell over on its side, the engine and one passenger car being wrecked. The engineman and fireman were killed.

A GRADE CROSSING DERAILMENT occurred Aug. 19 at Columbus, O., at the crossing of the Ohio Central Ry. and the Cleveland, Cincinnati, Chicago & St. Louis Ry. The tower man gave a clear signal for a train on the former line and then changed it to danger in the face of the train, with the result that the train was derailed by the derailing switch, but nobody was hurt.

THE SOUTH HALSTEAD ST. LIFT BRIDGE over the Chicago River at Chicago, Ill., was raised on Aug. 25 while an electric car was crossing. The signals were not displayed to stop the car, but the engineman claimed that a steamer was so close to the bridge that he had to raise it to avoid an accident. The passengers were considerably scared, fearing that the car would run off the end of the bridge span. The matter has been made the subject of an investigation.

THE FALSEWORK OF THE MISSION ST. BRIDGE over the Spokane River, at Spokane, Wash., gave way Aug. 25, and five men were injured. The men were raising some of the supports at the pier when the falsework broke loose from these supports and fell over.

A POWDER EXPLOSION occurred at the dryhouse of the Miami Powder Works, five miles from Xenia, O., Aug. 26, and two men were killed. The men were in the dryhouse when the 30 tons of powder in the building exploded.——An explosion of 5,000 lbs. of giant powder occurred Sept. 1 at the Equitable Powder Mills, Alton, Ill., by which three men were killed.

A FIRE AT ONTONAGON, MICH., on Aug. 26, practically destroyed the town, which had a population of about 2,000, and a number of people are thought to have been lost. An immense amount of lumber was destroyed, and the water-works plant and government breakwater were badly damaged, while the great works of the Diamond Match Co., valued at $1,000,000, were destroyed. The town is in the copper mining district and is the Lake Superior terminus of the Chicago, Milwaukee & St. Paul Ry.

THE COST OF THE NEW EAST RIVER BRIDGE is placed at $7,510,000 by the Chief Engineer, Mr. L. L. Buck, M. Am. Soc. C. E., in his statement to the Commission. It will require this amount to complete it by Jan. 1, 1900. The amounts estimated for the several parts of the work is given as follows:

Description of work.	Cost.
New York tower foundations	$500,000
Brooklyn tower foundations	860,000
New York anchorage	820,000
Brooklyn anchorage	820,000
New York tower, steel	186,000
New York tower, erection	124,000
Brooklyn tower, steel	186,000
Brooklyn tower, erection	124,000
Cable strands	450,000
Cable erection	300,000
Suspended superstructure, steel	966,000
Suspended superstructure, erection	644,000
Approaches, steel	780,000
Approaches, erection	520,000
Flooring, painting, &c.	230,000
Total	$7,510,000

THE HARLEM VIADUCT of the New York Central R. R. will not be opened to traffic before the end of this year, or perhaps next spring, according to the Chief Engineer, Mr. Walter Katte, M. Am. Soc. C. E. The reasons given are an injunction affecting the proposed Harlem station, and a law passed through the Legislature compelling the company to change its plans for the station at 125th St. The new station is to be under the structure, in the center of Park Ave., and it will cost about $95,000. The four-track drawbridge over the Harlem River and the approaches on both sides are completed and the tracks are already laid.

AN ELECTRIC DREDGE has recently been built by A. F. Smulders, of Rotterdam, Holland, for service on the Esla River, in Spain. It is a ladder dredge, and a 45-HP. motor running at 600 revolutions per minute drives the dredging chain, although the average power required is only 15 HP. The hoisting engines for operating the spuds are operated by motors, as are also the screws, the drums for raising and lowering the dredging chain, and a centrifugal pump. On the river bank is a power house with three-phase alternating dynamos delivering the current of 2,000 volts, which is transformed on the dredge to 200 volts. This plant also furnishes current for the motors which operate a discharging plant, which elevates the dredged stuff from the scows and loads it into railway cars.

THE DUPLICATE STEEL SUPPLY MAIN for the water supply of Newark, N. J., is practically all laid. It is 21 miles long, 48 ins. in diameter for about five miles and 42 ins. for the remaining distance. It parallels the 48-in. steel main put in use in 1892, but was laid in less than half the time taken in putting down the first one. Some trenching was done as early as the latter part of December, 1895, and pipe laying was begun in March, 1896, but none of the work, it is said, was pushed until April. The work has been done by the East Jersey Water Co., of which Mr. Clemens Herschel, M. Am. Soc. C. E., is engineer, with T. A. & R. G. Gillespie, of Pittsburg, Pa., as contractors. The same contractors laid the original pipe line.

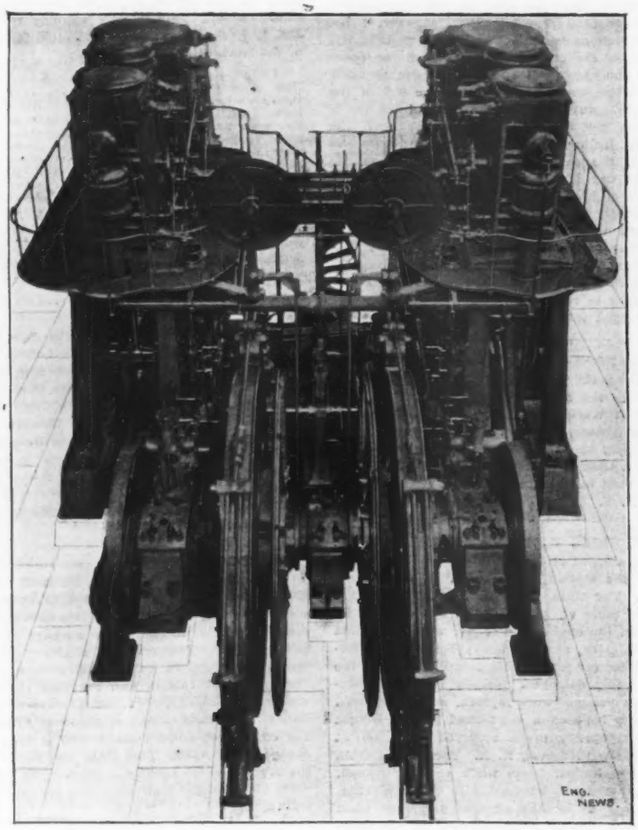
BIDS FOR PUMPING MACHINERY with a capacity of about 23,800,000 U. S. gallons are wanted by the Sanitation Board of the City of Mexico until Nov. 14. There may be one or more pumps, with a guaranteed duty of about 100,000,000 lbs. per 100 lbs. of Cardiff coal. Water tube boilers are required. The delivery from the pumps will be through a 42½-in. pipe, with an initial pressure of 17 lbs., water to be taken from a reservoir with a constant water level 5 ft. below "the level of the soil." The water pumped will be used for sewer flushing. Mr. Roberto Gayor, M. Am. Soc. C. E., is city engineer and Mr. Jose Ives Limantour is Chairman of the Sanitation Board of the City of Mexico.

THE GREAT HOISTING ENGINES FOR THE ANACONDA COPPER MINING CO.

Many of the large and deep mines in this country require very large and powerful plant for hoisting and pumping, and we illustrate, this week, two immense hoisting engines which have recently been built for the Anaconda Copper Mining Co., of Butte, Mont., by the Union Iron Works, of San Francisco, Cal. These engines were described to us during a recent visit to these works, and we are indebted to Mr. H. T. Scott, President of the Union Iron Works, for photographs and particulars of the engines, which have been named the "Aztec" and "Modoc." The larger view shows the engines in the erecting shop, at San Francisco.

Each pair of engines consists of one left hand and one right hand compound beam engine, connected to the reel shaft by disk cranks with crank pins set at right angles.

The cylinders are vertical and inverted, each engine having one high pressure cylinder, 26 × 72 ins., and one low pressure cylinder, 46 × 72 ins. The pistons are connected to opposite ends of the beam by piston rods, crossheads, and reach rods, or links. At the top, or king post, of each beam, one of the main connecting rods take hold, while the opposite end of the rod is connected to the crank pin, thus giving at all times a positive stroke of 72 ins. to the pistons.



END VIEW OF HOISTING ENGINES FOR THE ANACONDA COPPER MINING CO.
Union Iron Works, San Francisco, Cal., Builders.

The high pressure cylinder is located in front of the low pressure cylinder and a reheater is placed between them. The high and low pressure cylinders are steam jacketed, and the water of condensation is automatically carried off from the jackets by steam traps, which discharge into feed tanks or condensers. The cylinders of each engine are supported by a cast-iron framing, consisting of four vertical and four diagonal columns, resting on a heavy bed plate and securely bolted thereto. All the cylinders are covered with teak wood lagging, and have highly finished metal covers.

The main valves of each engine will be of the Corliss type, worked by a wrist plate, which derives its motion from an eccentric on the reel shaft, and a crank on the beam pin. The valve motion is a modification of the Walschaert valve gear. The reversing gear is operated by a separate engine and hydraulic controlling cylinder. The cut-off valve gear mechanisms on the low pressure cylinders are adjustable by a hand lever or governor, as desired, and the cut-off valve gear mechanisms of the high pressure cylinders are controlled by a governor and by a hand lever on the working platform.

The beam center bearings and the main bearings for the crank shaft are cast in and form a part of the main sole plates. All the bearings are substantially fitted and provision is made for adjustment to allow for wear of the moving parts.

There are two reels or drums on each crank shaft, each having a capacity of about one mile of flat wire rope. The reels may be operated independently of each other or in balance as desired. Each reel is fitted with a patent friction band clutch applied by an entirely separate engine, and hydraulic controlling cylinders. The reel brakes are of the Post pattern, with beams of heavy cast iron, securely braced with steel rods, tied together top and bottom. Each is operated by a separate engine and controlled by hydraulic cylinders.

The auxiliary engines for working the reel brakes, reel clutches, reversing gear, and disk brakes, are operated by hand levers, all grouped conveniently together on the operator's platform, which is located between the engines, and forms a part of the main engine gallery. There are eleven separate engines to each pair of these hoisting engines.

To the end of the rope on each reel is secured a four-deck cage, which when loaded and in full motion in the shaft will travel with a velocity of 40 ft. per second. Each reel is provided with a very ingenious rig for indicating the position of the cages in the shafts, and the speed at which they are traveling.

A governor is fitted to each pair of engines, which, when at full speed, assumes entire control of them, giving a uniform speed to the cages, and regulating the valve-gear tripping mechanism to cut off at the most desirable portion of the stroke, which means an economical distribution of steam in the cylinders and an economy in fuel consumption.

There is one main central winding stairway leading up to the upper gallery or operator's platform, with numerous smaller platforms, giving access to all the parts of the engines requiring constant attention and adjustment. The platforms are provided with iron stanchions, capped with brass hand railing, neatly designed and highly polished. Brass drip pans are provided to catch any waste oil from journals, and all piping used around the engine is of brass.

To work one pair of these engines in all their requirements, the man has seven levers and one foot lever to operate, while just in front of him are located the two dials or indicators, which require his constant attention while the cages are in motion.

Each pair of hoisting engines weighs about 400 tons, and the rated power of the two sets of engines is about 5,000 HP. The engines are said to be the largest of their kind in the world

NOTES OF A TRANSCONTINENTAL TRIP.

(Editorial Correspondence.)

I.

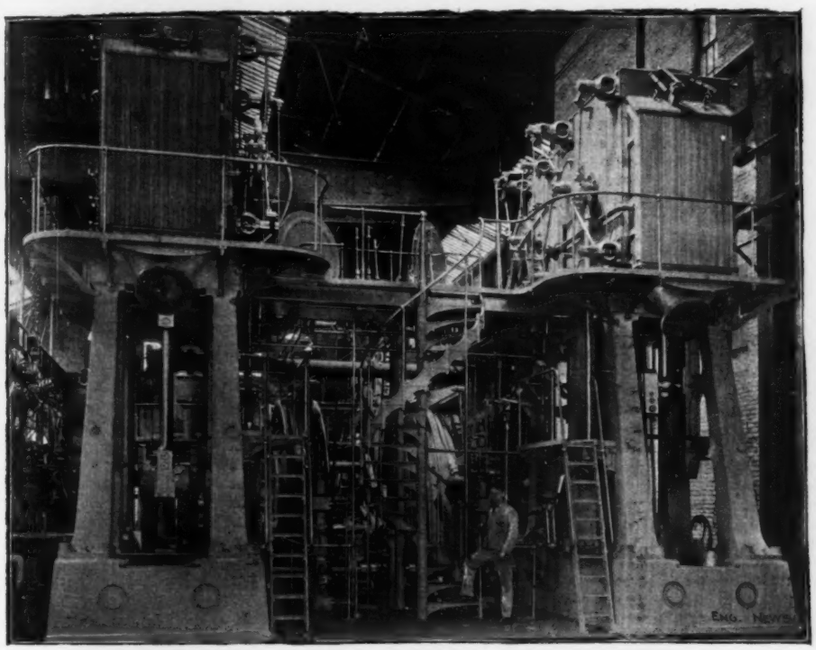
It had been my intention to attend the annual convention of the American Society of Civil Engineers, held in June, at San Francisco, Cal., and to accompany the party on the special train from New York. Circumstances, however, prevented this, but as all preliminaries had previously been arranged it was eventually decided to make an independent trip later to the Pacific coast, and to spend some time looking up friends of Engineering News, and in looking up work in the "far west" that would be of interest to its readers.

Erie Railway.

The first stage of the trip was made on the Chicago Vestibule Limited express of the Erie Ry., leaving New York at 2 p. m., on June 30, and one of the first points calling for comment was the apparently small percentage which this route receives of the heavy through traffic between New York and Chicago, meaning thereby the first-class traffic on the express trains more especially. The time is convenient (the Vestibule Limited leaving New York at 2 p. m., and arriving at Chicago at 5 p. m. the next day), and, as was explained in an editorial on "Accelerating the Speed of Express Trains" (Eng. News, Sept. 19, 1895), convenience of time in train service is a greater aid to the encouragement of traffic than is a mere matter of actual speed, or a little saving in time, though as far as this is concerned the speed on the Erie Ry. is practically equal to that of its competing lines. The road is well built and well managed; it is operated on the block system for the entire distance of 998 miles (which at present includes a considerable stretch of single track); the equipment cannot be surpassed by that of any other road in point of comfort, convenience and ease of riding; and the attendance and service on the cars is all that could be desired, while besides all this there is an abundance of fine scenery along a large part of the line. In spite of all these advantages, however, the number of passengers on the through cars has been found on more than one occasion to be comparatively small, which is an additional point of convenience to the passengers themselves, but is not a source of satisfaction to the railway company. Perhaps one reason for this is the unfavorable reputation which the railway acquired in years past, and which still exists as a difficulty which the present management has to contend with in its endeavors to increase the patronage, in spite of which the management has had and is having considerable success in building up its traffic. It is earnestly to be hoped that the many financial troubles of this important system may have been practically terminated by the recent reorganization, and, as has already been noted, there are now but few objections to be made from a passenger's point of view. As to the general aggregate of the through traffic it appears

from official information that this line is at least holding its own.

The construction, track and equipment of this road have been described at various times in Engineering News, more especially in the issues of Feb. 8, 1894, and Jan. 9, 1896, and these matters need not therefore be dealt with here. Reference may, however, be made to the excellent standard of maintenance and discipline generally observed. New ballast is being put in quite extensively, but some parts of the western divisions are still very dusty, and an extension of the use of stone and slag ballast as means will permit, will add considerably to the comfort of passengers. The Chicago & Erie Division is being largely relaid with 80-lb. rails, having suspended, broken joints, splic.d with six-bolt angle bars. Two important improvements in operating, which have recently been put in force, are (1) the making up of freight trains on a tonnage basis (that is to say, by actual weight of train instead of by a fixed number of cars); and (2), giving the freight engines a straight run of 192 miles (from New York to Susquehanna) instead of changing engines at Port Jervis and thus making two runs of 88 and 104 miles. The advantages and economies resulting from these improvements were editorially commented upon in Engineering News of July 23, 1896. The Chicago



THE GREAT HOISTING ENGINES FOR THE ANACONDA COPPER MINING CO.
Union Iron Works, San Francisco, Cal., Builders.

Limited express on the particular date of this trip (June 30) consisted of a powerful ten-wheel engine of the class now largely used for fast and heavy passenger trains, a mail car, baggage and smoking car, day car, Chicago sleeping car, Cleveland sleeping car and Cincinnati sleeping car, this latter having a drawing room and a roomy observation platform fitted with camp stools.

One point which seems to call for criticism in this train service is the method of handling the dining car service. Formerly the dining car on this train was run through for the entire distance, but now dinner is served on a dining car which runs through from New York to Susquehanna, and breakfast is served on a dining car put on at Kent (6.50 a. m.) and taken off at Marion (10.15 a. m.), while lunch has to be scrambled for in an ordinary eating house at Huntington during a stop of only ten minutes, which is a very inconvenient and unpleasant arrangement, especially in bad weather. Of course a through dining car means hauling an extra dead load for many hours, but it ought to be practicable to extend the run of the dining car to include lunch time, or at least to furnish a buffet lunch, as a lunch stop is certainly beneath the dignity of a "Chicago Limited." It is said that when the cars were run beyond Marion to serve lunch the patronage was so light that they were taken off to save the 254 miles extra mileage and the loss on the meals, but it is difficult to see why this should be, especially if the ten minutes stop at Huntington was reduced to an ordinary stop, since no passenger having breakfast before 9 a. m. would want to go without any meal until after 5 p. m.

Dining Car Service.

In the operation of through trains on very long distances an important point for consideration is the best method of arranging the dining car or eating accommodation so as to most satisfactorily meet the comfort and convenience of the passengers as well as the operating requirements. The three principal methods are as follows: (1) To run a dining car right through with the train; (2) To attach a dining car every morning and cut it off at night; and (3) To provide a buffet car service. The first method is undoubtedly the best as far as the convenience of the passengers is concerned, and it insures a supply of provisions in case the train is delayed or the line is blocked, but on the other hand, it involves the hauling of a considerable extra dead load which may be a serious objection on lines having heavy mountain grades. This plan is, nevertheless, adopted by the Northern Pacific R. R. for all its transcontinental trains, between St. Paul, Minn., and Portland, Ore., 2,056 miles. The second method is almost as good as the first, under all ordinary conditions, provided that the car is put on sufficiently early and not taken off too soon, although it often happens that the schedule cannot well be arranged to make this fit in conveniently with the time of arrival at divisional points between which the cars run. Should the train be late, however, in the morning, the absence of breakfast will cause considerable grumbling, while in case of a block or a breakdown the lack of provisions may be very inconvenient. This method is employed by the Canadian Pacific Ry. for its transcontinental trains, at least east of the Rocky Mountains, and in one particular case on that road an accident in winter blocked the track and the Pacific express, minus a dining car, was held for a day or more on the track amid the snowdrifts. Through the Rocky Mountains no dining cars are used, on account of the heavy grades on the line, but the trains are timed to reach the company's hotels at meal times, and it must be said that a very exceptionally good service is maintained at these places, far superior in fact to any other railway eating house at which it has ever been my fortune to take a meal. The meals are excellent, and well and promptly served, but without the slightest hurry or bustle. The amount and character of the traffic, as well as the character of the line, must, of course, be taken into consideration in deciding which of these methods should be adopted in any particular case. In any case it is important to have the meals served at convenient hours, but this is not always done, as for instance, on one part of the run of the eastbound trains on the Canadian Pacific Ry., where breakfast is served at 8.30 a. m., lunch at 11.30 a. m., and dinner at 5.30 p. m. The first interval is too short, and the time for dinner is too early, especially as the car is run until 7.45 p. m. The buffet car service is not adapted for very long runs, but is specially convenient for day runs (serving two or three meals) or night runs (serving supper and breakfast) of 10 to 14 hours' duration. It is also very convenient in cases where single through cars are run, being attached to different trains on the different lines forming the route. In the buffet car, as is well known, the car porter cooks and serves light meals in the car, the charges being a-la-carte, while on the dining car there is usually a fixed price of 75 cts. or $1 per meal, though some roads (including the Union Pacific Ry.) serve meals a-la-carte on the dining cars. For first-class traffic it is not enough to stop the train for 10, 20 or 30 minutes at an ordinary railway eating house, as the hurry and scramble and the character of the food do not suit persons in delicate health or with weak stomachs. This plan is, however, followed on some lines, but while the patronage may not be enough to warrant a dining car service it would in most cases warrant introducing a buffet service on the sleeping or parlor cars. The dining car service is usually operated by the Pullman or Wagner palace car company, under contract, and at a loss to the railway company, but in some cases the railway company could operate this service more profitably, and the Baltimore & Ohio R. R. has recently purchased the dining cars of the Blue Line express trains between New York and Washington, and will operate them under its own management, as they have hitherto been operated by the Pullman Palace Car Co. at a loss to the railway company. It is a common practice to run dining cars on express trains running distances of 100 to 400 miles, as between New York and Philadelphia, Boston or Buffalo. The Lehigh Valley R. R. has also a unique lunch car service on excursion and day trains, the car being fitted with a regular lunch counter where light refreshments are served.

Chicago.

This city was reached at 5 p. m., July 1, and was left again at 6 p. m., on July 2, only one day being spent here, as all engineering matters of interest in that vicinity are well looked after by the Chicago editor of Engineering News, and it was a relief to get away from the heat and humidity of that city.

One of the striking pieces of engineering work now in progress is the lowering of the grade of the Illinois Central R. R. along the lake front, and the reclamation of submerged land to form a park east of the railway. Practically the whole of the lake front, for a long distance south from the mouth of the Chicago River has been occupied by the railway, but now there is to be eventually a fine lake front park close to the main business part of the city, similar to Lincoln Park and Jackson Park in the north and south suburban districts of the city. A bulkhead or sea wall, 6,200 ft. long, is now being built 1,250 ft. from the shore, and the space between this and the present shore will be filled in, forming a park of some 164 acres, the grade of which will be sufficiently high above the railway to allow of bridges spanning the tracks. The filling in, on such a large scale, will be quite an interesting piece of work in itself.

Another noticeable work is the construction of the terminal loop for the joint use of the several elevated railways, and while this will be a great advantage to the local traveling public, it must be said that the structure is very detrimental to the

appearance of Van Buren St. This work was described in Engineering News of July 16 and Aug. 20, 1896. The demolition of the old Post Office, to make way for a new structure (with presumably better foundations) on the same site, is an indication of progress. The noted Grand Pacific Hotel, opposite the Post Office, is closed and is to be pulled down, while on its site a trust company intends to erect a one-story business building for its own sole use and occupancy, the idea being to follow somewhat the plan of the Bank of England (in London). Thus Chicago, which first began the craze for sky-scraping buildings of 15 to 20 stories (and which has now been surpassed in this respect by New York), has now gone to the opposite extreme, and will have a lowly (though by no means a humble) one-story structure in that section of the city where 12 to 15-story buildings are quite common. There is no indication, however, of any cessation of the construction of tall buildings. At Lincoln Park may be seen the great 250 ft. Ferris wheel from the Columbian Exhibition, and the taking down and re-erection of this wheel must have been a complicated and troublesome work. It is now in a small private park, operated by a syndicate, but as this syndicate has not been able to secure a liquor license, it does not seem likely that the park and wheel will be a popular resort or a profitable enterprise. One must not leave Chicago without a reference to its Drainage Canal. The main work of the canal proper is now practically completed, and its extension to the lake is now being advocated by those who look upon the drainage channel as a part of an important navigable canal to connect Lake Michigan with the Mississippi River.

Chicago & Northwestern Ry.

The Wells St. terminal station of this road is not very large or imposing, but the long through trains which one sees in the station, with cars labeled for various far away cities, give an impression of the great extent of the railway system and its direct connections. It may be noted in passing that this is one of the few American stations at which a service of porters has been established, but while these red-capped assistants are conspicuous enough they are not very alert or attentive, and are in no way to be compared with the prompt, active and obliging (albeit somewhat obsequious) porters who abound at all the English terminal stations. The same remarks apply to all the station porter services in this country, which have come under my notice, including those at the Grand Central Station, New York, and the Union Station, at Boston.

The route of the Overland Limited express for the Pacific coast is by way of the Chicago & Northwestern Ry. to Omaha, the Union Pacific Ry. to Ogden (through Cheyenne), and the Southern Pacific Ry. to San Francisco. This train leaves Chicago at 6 p. m., and is due at San Francisco, 2,357 miles, at 8.45 p. m., the second day, or in 74¾ hours. On July 2 this train consisted of eight cars, as follows: Union Pacific Ry. baggage and smoking car, Pullman sleeping car for San Francisco, three Wagner sleeping cars for Salt Lake City, Hawarden and Sioux City, a through dining car for San Francisco (on which meals are served a-la-carte), a Union Pacific Ry. reclining chair car for Ogden and a Chicago & Northwestern Ry. day car in the rear. The locomotive was the powerful eight-wheel engine, No. 908, illustrated in Engineering News of Jan. 9, 1896, which was one of several built by the Schenectady Locomotive Works, of Schenectady, N. Y., and designed specially for high speed with heavy trains between Chicago and Omaha, 492 miles. These trains have from 8 to 11 cars, with sometimes as many as 6 sleepers. The engine has cylinders 19×24 ins., driving wheels of 6 ft. 3 ins. diameter, and weighs 125,600 lbs., with 78,000 lbs. on the driving wheels. Its appearance is somewhat grim, being painted entirely black, relieved only by the glistening of the varnish and the bright finished edges of the coupling rods, which are of I-section.

In leaving Chicago the great amount of work for the elevation of the tracks above the street grade (Engineering News, Aug. 20, 1896) is very noticeable, as is also the extensive use of the Hall automatic block signals. During the night a furious and long continued thunderstorm on the plains necessitated the slowing down of the train on account of fear of washouts, the torrents of rain obstructing the view almost like a solid wall of water, while the vivid and almost incessant flashes of lightning blinded the eyes. This road has a very good and easy riding track, and on double track divisions the trains run on the left hand track, which is contrary to the general custom.

Omaha, Neb.

This city was reached at 8.10 a. m., July 3. The train makes a stop of some 15 minutes at Council Bluffs, Ia., on the east side of the Missouri River (which is not a very imposing stream at this point) and in the yards the train has its running gear inspected and the tanks of the cars supplied with water and ice. After this it crosses the river and enters the city of Omaha, which is noted as the starting point of the Union Pacific Ry. (for the first transcontinental line) in 1865. The city has a population of about 150,000, and is 1,031 ft. above sea level.

Leaving the train to proceed on its way, a few hours were spent here, but the heat and humidity made a combination unfavorable to much sight-seeing. Here, as in most of the large western cities, one cannot but be struck with the number of large and handsome office buildings, many of them owned by insurance and trust companies. The main part, or business section of the city, is of good appearance, but everything appeared to be very quiet, with little business in progress, times being dull now all over the country. The city has suffered somewhat from a land boom of some years ago, when prices became inflated and everybody was buying and selling land, but this boom died out or collapsed, as booms do, and left more or less injurious effects behind. However, the city is an important railway and commercial center and has some manufactories, distilleries, smelting works, linseed oil works and large meat packing establishments, ranking the third city in the country in this latter respect. The general offices and the extensive shops of the Union Pacific Ry. are also located here. A Trans-Mississippi Exhibition is to be held in Omaha, from June 1 to Nov. 1, 1898, and is intended to be an exhibition illustrative of the resources, products and possibilities of the western regions, and designed particularly to educate people in the east and south as to these matters. This was decided upon in 1895 at the eighth convention of the Trans-Mississippi Commercial Congress, and the matter has been energetically pushed, while the U. S. Congress has appropriated $200,000 towards the expenses of the exhibition. Mr. G. W. Wattles is President of the exhibition, and Mr. C. F. Weller is President of the Omaha Commercial Club.

The union station is at some distance from the business section of the city, and is an old, shabby, one-story frame structure at the side of the track, having been built apparently in the early days of the Union Pacific Ry. It has no trainshed, no modern conveniences, and only a very third rate dining-room and lunch counter. Some time ago the Union Station Co., in which the Union Pacific Ry. is interested, received authority and assistance from the city to build a new station close to the old one, but on the opposite side of the tracks, the city voting bonds to assist the project. Work was commenced and the lower part of the building practically completed, when the city made objection that the plans submitted by the company were not being strictly adhered to, but that certain dimensions had been reduced. The repudiation of the bonds was threatened, and this led the company to stop work and the railways to abandon the project. The partly completed building (which appears to have been designed as a handsome and commodious structure of brick, stone and iron), remains a weatherbeaten monument to the difficulty of ensuring harmonious relations between railway and municipal authorities. A project now on foot is to build a new station on a different site, more nearly within the city, and accommodating some other roads. This station would be a terminal having a headhouse, which does not seem to be the most desirable plan for a station which has to accommodate so much through traffic, as was noted in Engineering News of July 16. Wherever the new station may be located it should certainly have a trainshed, as no amount of splendor or comfort in the station building can compensate for the inconvenience and discomfort of passing between station and train during rain and snow. Yet it must be said that this is a common defect of many new and handsome stations, not even the makeshift of a shed roof over the platforms or between the tracks being provided.

(To be continued.)

THE REQUIREMENTS OF TIE-PLATES FOR RAILWAY TRACK.

By Benjamin Wolhaupter.

As soon as George Stephenson triumphed with his locomotive "Rocket," in 1829, he became the recognized authority in railway construction, and he adopted the fish-bellied rail with chair supports, which had already been in use for some time. The rail was first laid without chairs, these supports having first been used about 1797. The use of such chair supports has been continued in service in England on all up to the present day, but with the bull-head rail. In America they were soon discarded, the Stevens flange or T-rail being adopted, made with a flat base and spiked directly to the ties, and the chairs placed only at the joints. Under these conditions the chairs were subjected to a heavy rocking and pounding action by the passage of the train over the light iron rails then used, which soon battered out the joint ties and the rail ends. These joint chairs have long ago been obsolete, having given place to the more scientific fish plate joint. On account of the great weight and the looseness of the joint chairs, and the alternate loading on one side and then the other, and the hammer blows before mentioned, they destroyed the joint tie rapidly, and have remained up to the present time in much disfavor with old engineers who once used them. Hence it was that the first tie-plates were received with much skepticism by engineers, and it is even now not fully recognized that the tie-plate is distinct from a chair. Much credit is due to Mr. Benj. Reece for the manner in which he has carried out his practical tests with tie-plates, and educated the engineering world away from the false impressions formerly existing regarding them.

The tie-plates are placed directly upon wooden ties, and we find that all wood is composed of a fibrous, cellular or minute tubular structure. This is of two kinds in the same wood; one kind practically open, thin-shelled tubes called "ducts," which when new are filled with sap, and when old, filled with air. The other is of a hard dense, thick-shelled nature, and is called the "woody fiber," and is the "substance" of the material, and it is through these cells that the sap flows. It is thus evident, that to entirely exclude moisture and air it is necessary to compress the walls of these tubes together and keep them so compressed. In "soft woods" the shells or walls of these "woody fiber" tubes are thin, and consequently allow of great compression. In "hard woods," on the other hand, they are thick and strong, and leave little room for the sap to ascend through them. Therefore, a certain definite pressure applied to the former will compress them (squeezing out the air and moisture) to a greater extent than it will in the latter.

The prime requisite of all "base" of track below the rail head, whether of rail, plates, ties, or ballast, is to carry the loads received from the wheel treads and equally distribute them to the roadbed (which is the final supporting medium) in such a manner that no single part shall receive, and be required to transmit, a strain beyond the elastic or crushing limit of its component particles. Where this is not carefully guarded against, rapid deterioration takes place and soon complete destruction.

Except during the coldest weather in the northern section of this country, all ballast is flexible and forms a yielding support to the track. The rail also is flexible and will bend and spring within the elastic limits of the steel of which it is composed. Therefore, when a heavily loaded wheel passes over the track, depression of the rail immediately below the wheel takes place, the adjacent ties supporting the rail will force it into a

curve, thus tending to raise it off the second ties from the wheel, to be instantly forced onto the tie as the wheel reaches it. Thus is produced a certain undulatory or wave motion in the track, which may cause the rocking or churning of the tie as the wheel passes over it, a rise and fall of the rail on the tie, and also a longitudional movement of the rail bodily. We will call these the first forces acting on the tie-plate, and will call them longitudinal and rocking forces. Under excessive loads, light rail and poor ballast, these conditions are magnified.

Fig. 1 shows tie plates in use with the above conditions of forces on an exaggerated scale. It will be seen that the tie-plate will first receive a blow and then a heavy load on one edge, forcing this edge into the tie, compression of the fiber under this edge takes place, lifting the other edge off the tie. Next the middle of the tie is loaded centrally, and finally the opposite edge of the plate is loaded, forced into the tie, lifting the other edge of the plate off the tie, the tie moving in the ballast to correspond slowly with the action as above. This action will increase with the width of the plate and the softness of the tie. It is similar, also, but in a minor degree, to the action of the load on the old joint "chairs" in use on iron rails, and would in time cause the destruction of the tie, unless the plate is immovably fixed thereon. This

Fig. 1.

deleterious action can be entirely overcome by giving a central point of support on the plate as shown in Fig. 2, or by making the plate sufficiently narrow. Some well-known plates have been made 6 and even 10 ins. wide, with a smooth top surface, but experience has shown that they would rock on the tie, become loose, and soon grind out.

One of the most detrimental actions of track in practice is the rise and fall of the rail on a flat plate. With high speed the rail is raised instantly off the plate on which a close contact had been previously maintained. At once air rushes in with excessive velocity, carrying with it sand and other gritty particles. This sand grinds between the rail and the plate, and as is perfectly clear on examination of an old plate, wears a thin plate through in a short period. The larger the rail base and the plate, the greater the velocity of the air and the greater the tendency to suck in grit. This

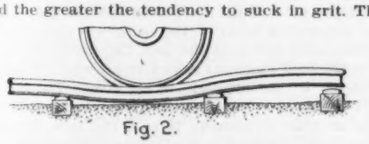


Fig. 2.

grinding of the sand on the plate is one of the chief sources of destruction of tie-plates in practice.

The second and greatest loading on the plate is the vertical loading, produced by the wheel and its superincumbent load applied to the rail head, and through it and its base direct to the tie-plate. Referring now to Fig. 3. This vertical force is applied to the rail head at G, and is then transmitted vertically through the rail web to F, where the web joins the base A B. Here the tie-plate takes it and is called upon to distribute it over the tie and out to its outer edges at C and D, and in doing so must not have its fibers strained beyond their elastic limit. If they are so strained, the plate will buckle or curl up at the edges of the rail flanges, because there the greatest bending moment occurs, and the plate will assume the shape shown in Fig. 4. It will then become loose and rattle; will suck moisture beneath it and will apply a hammer blow to the fibers of the tie as the wheels pass over it.

There are three methods of preventing this bending of plates: (1) increasing their thickness; (2) decreasing their length; or (3) adding vertical ribs or "girders" from end to end of the plate. If the first method is resorted to, the plate becomes too heavy for economical practice, and at the same time from its inertia cannot be immovably secured to the tie. By the second method the area of bearing on the tie is greatly reduced. By the third method the objections to the two former are answered, and the exceedingly important feature of providing successful means for securing the plate to the tie is obtained by opening up the grain of the wood and placing the flanges therein.

Considering the plate strong enough for this purpose, it is next the duty of the fiber of that

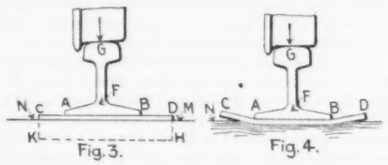


Fig. 3. Fig. 4.

part of the tie immediately beneath the plate, namely D, H, K, C, Fig. 3, to support this distributed load without being crushed or torn away from the adjacent fibers at M and N. From the spaces beneath the plates this force is distributed through the tie to the ballast beneath.

For the simplification of this question of the vertical force, let us assume that each tie supports its own section of rail and is called upon to individually carry the load coming to that section. The loads we find as follows:

Locomotives (Central R. R. of New Jersey), 88,400 lbs. on 4 drivers; 22,100 lbs. on 1 driver.
Modern box car (light weight), 32,000 lbs.; full load, 60,000 lbs.; 92,000 lbs. on 8 wheels, 11,500 lbs. on 1 wheel.

Considering now the effect of these loads upon the two extreme cases of cedar and oak ties we find that with a 60-lb. rail having a base 4¼ ins. wide, resting on a standard tie 6 × 8 ins., the area of contact will be 4¼ × 8 ins., or 34 sq. ins., on which a load of 22,100 lbs. will give 650 lbs. per sq. in. The effect of this load passing over at high speed and thus being suddenly applied should be considered as double this, or 1,300 lbs. per sq. in. The wood of ties used varies in different sections of the country, and includes soft white cedar, cypress, redwood, chestnut, pine and hard oak. Considering the compressibility of the tie, we find that the extensive U. S. government tests of the compressibility of woods at Watertown, Mass., show that 0.1-in. of indentation is made on unseasoned cedar with a load of 450 lbs. per sq. in.; on thoroughly seasoned cedar, 900 lbs. per sq. in.; on unseasoned white oak, 2,000 lbs. per sq. in.; and on seasoned white oak, 4,000 lbs. per sq. in. The pressures on other woods to give a like indentation varies between these two extremes in the proportion of the hardness of their fibers. It is thus clear that with a perfectly vertical application only of the above loadings it is only in the softer woods when moist that the fibers will crush and destroy the life of the tie.

The above examples are of extreme conditions of the present practice as to loading, conditions of wood and width of rail base, and hence it would appear that under favorable conditions no additional bearing surface in the form of a tie-plate would be required in addition to the ordinary rail base, even on soft ties, to take care of this vertical load.

The third loading or strain applied to tie-plates

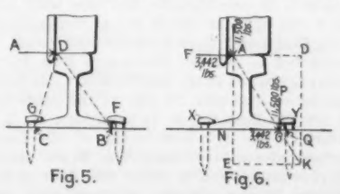


Fig. 5. Fig. 6.

is apparently insignificant except upon the sharpest curves. It is a lateral force and is caused on curves by the centrifugal force produced by the load moving around the curve. It is applied to the rail head by the wheel flange and is carried through the web to the base and there applied to the tie-plate and spikes, and through them to the tie. On tangents this force is produced by the swaying of the train, side winds, unlevel track and trucks skewed out of square, and though apparently comparatively slight, produces with the other before mentioned forces, the chief source of tie and tie-plate destruction.

Referring now to Fig. 5 and considering that this lateral force is applied at the head of the rail at D in the direction A D we see that it thus tends to move or slide the rail laterally on its base B C until it comes in contact with the spike F, after which the tendency is for the rail to revolve on its edge B, elevating the other edge C and drawing spike G. This latter action is prevented by the vertical load from the wheel. In fact it is necessary to consider both of these forces together. Considering now both of these forces together and applying them as produced by the car before mentioned, we get the forces shown in Fig. 6 (where spikes G and F are marked X and Y respectively).

By assuming an extreme case of speed of 40 miles an hour around an 8° curve and using the formula:

$$f = \frac{w\,v^2}{32.166\,R}$$

(Searles' "Engineers' Pocket Book," p. 177) for the centrifugal force, where f = centrifugal force, w = weight of car in pounds, v = velocity of car in feet per second, and R = radius of the curve in feet. In this case w, on one axle, is 23,000 lbs.; v is 40 miles per hour, or 58.67 ft. per second; R is an 8° curve, 716.8 ft. radius, thus giving us a horizontal force, f, of 3,442 lbs. We have already a vertical force of 11,500 lbs. applied to point A. Forming now the parallelogram of forces A D K E we find a resulting force acting in the direction A K and striking the rail base at G, where it is

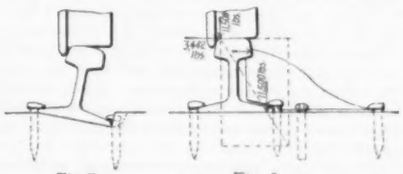


Fig. 7. Fig. 9.

again resolved into the original forces of 3,442 lbs., acting along the base of the rail in line N G and 11,500 lbs. acting vertically in line P G. In an 80-lb. rail G comes within ⅜-in. of the edge of the base.

We have now the most serious and extreme condition in which ties and plates are placed, and under which ties will cut, and improperly designed tie-plates will fail. Assuming that this 11,500 lbs. of vertical force applied at ⅜-in. from the edge of the rail is distributed over 8 ins. of tie for a width of ¾-in., we now get a loading on fibers of 11,500 lbs. divided by 6, or 1,917 lbs. per sq. in. This pressure will cause a very decided compression of the fibers of all of our tie woods and even of the hardest oak along the edge of the rail at Q, as before shown, and as the wood gets old this will soon cause destruction. At the opposite edge but little pressure exists.

It has just been shown, however, that except under the extreme conditions found in practice a purely vertical force will not destroy a soft wood tie. We now find that under ordinary conditions with a lateral force added to the vertical, we get a destructive force even for the hardest oak. Further we have a horizontal force which moves the rail until it comes in contact with spike F (or Y) under this extreme vertical pressure. These two combine to rapidly destroy the fibers even of the hardest wood on this side, and as they give way the rail cants, thus throwing the resulting forces nearer the edge of the rail flange, which soon throws the rail into the position shown in Fig. 7.

This concentrated vertical pressure and the lateral pressure causing movement of the rail, combined with the destructive abrasive action of the sand on the wood fibers beneath, is the chief source of tie-plate wear, and can be avoided only by a carefully designed plate. The plate, however, must be fast to, or embed itself in the tie, otherwise there will be movement between plate and tie which will also cause absorption of moisture and sand, severe abrading action and complete destruction of the tie. The eccentric loading, however, not being so great as with a rail alone,

it will take a greater period of time to cause such destruction.

This before-mentioned lateral pressure and its resulting action are the cause of the chief differences of opinion among the advocates of the two types of tie-plates.

Considering now the resistances encountered by this force from the base of the rail until it is absorbed in the tie, we find that this lateral pressure is absorbed (1) by the friction of the rail on the tie or plate, and (2) by the resisting action of the spike. As the tie becomes smooth, the co-efficient of friction will amount to 0.18 (Trautwine's "Engineers' Pocket Book," p. 373, steel, on smooth mahogany) or 2,070 lbs., leaving 1,372 lbs. to be resisted by the spike. Allowing now the very low shearing strain of 30,000 lbs. for iron used in spikes, we have for a spike 9-16×9-16-in. square, 0.316 sq. in. of area, or 9,490 lbs. of shearing strain to resist a thrust of 1,372 lbs.

Though the spike will not shear under these conditions it is supported by wood which may compress and give way. Assume that for 2 ins. down the spike the fibers of wood are compressed, and we have 9-16 × 2 ins., or 1,125 sq. ins., or say 1,220 lbs. per sq. in. on the fiber produced by the 1,372 lbs. of thrust. If there is any material rail movement before the rail strikes the spike and a blow is given, this should be doubled, or say 2,440 lbs. The resisting power, however, of the end of the fibers amounts to from 4,400 lbs. per sq. in. in cedar to 7,000 lbs. per sq. in. in oak. On a bare cedar tie we thus have a factor of safety of 2.

If a tie-plate is used under the above conditions, we have a co-efficient of friction of 0.14, or 1,610 lbs. of friction on the plate, leaving 1,732 lbs. to be resisted by two spikes, and if the plate is punched, as it should be, in such a manner that no rail movement is allowed between the spikes, we thus obtain with a tie-plate a factor of safety of nearly 6 under these conditions with cedar. This factor of safety certainly should be all that is required.

In the above examples, forces and conditions were considered which can be readily ascertained. In practice, however, these conditions will vary, and when varying can never be accurately obtained. They may be varied for such reasons as the following: Short sections of track may have very narrow rail base, gage of track may be tight, locomotives may have long, stiff wheel base and frames, ties may be old, besides which spikes when driven are not entirely supported by the end wood but partly by end wood and partly by side wood.

The conditions of these forces, as has been shown, require a narrow plate or one with a raised center; they also require one which will collect little or no sand. The Wolhaupter plate (Eng. News, July 18, 1895, is only 4¼ ins. wide, and can be made with a raised or crowning center, under special patents. It also has channels on top, thus allowing large air ducts beneath the rail, which greatly

Fig. 8.

reduce the velocity of the inrush of air and at the same time afford channels for collecting grit or sand that may get beneath the rail base. In practice this is very noticeable.

The vertical force was shown to amount to 650 lbs. per sq. in. on an area of 4¼ × 8 ins., which is also the size of this style of plate. This loading on a cedar tie was not injurious, and as the plate has bottom flanges it carries this loading right to its extreme ends without buckling. The lateral force combined with the vertical has been shown to move the rail on the tie under a large vertical load and to rapidly disintegrate the wood fiber thereby and to be the chief source of tie destruction. The Wolhaupter tie-plate has flanges which embed themselves parallel with the grain of the wood and is therefore held firmly by such flanges, it being a well-known fact that the expansibility of wood is almost entirely at right angles to its fibers. In a heavy terminal yard with excessive traffic, where the Wolhaupter plate, a plate of the same type and one of a type having flanges cutting across the fibers were placed, the former plate was in for ten months; the others for seven months each. The plates having flanges across the grain had 1% tight at the end of the seven months; the plate of the same type as the Wolhaupter had 16.7% tight at the end of seven months; the Wolhaupter plate had 34.5% at the end of ten months.

A great source of tie destruction, in addition to the action of the forces above mentioned, is the natural decay of the wood. This decay is caused by the alternate absorption and evaporation of water, which action a flat or loose plate will of course increase. The flanges of the Wolhaupter plate being V-shaped on top, compress the upper fibers of the wood to such an extent as to tend to prevent absorption of moisture. Careful examination will show that if chisel-pointed flanges are driven into soft wood parallel with its grain, the top surface of the wood is readily penetrated by the flanges, The fiber immediately beneath is, however, carried down with the flanges, and thus forms a pocket or receptacle for moisture immediately beneath the surface of the tie and next to the flange of the plate as shown in Fig. 8. The plate having these V's at the upper end of the flanges compresses the surface fiber down into these cavities, filling them and preventing the collection of moisture at these points.

A slight consideration of the strains placed upon tie-plates and rail braces will show readily which of them must of necessity be the preferable.

In Fig. 9 we have a rail brace, and (as before illustrated in Fig. 5) vertical and lateral forces produced by a loaded car on a curve. We see that here the only force which the rail brace is capable of resisting is the lateral or horizontal one of 3,442 lbs., which is only one quarter of the other or vertical force; in other words, the rail brace is placed to resist this small force, and the greater force of 11,500 lbs. takes care of itself on soft woody fiber. This might be possible if the braces were absolutely tight against the rail head, but in practice this is not so, and the moment looseness occurs between the head of the rail and the braces, we get a concentrated load at G as before; then the tie cuts, the rail cants and carries down with it the head of the brace, at the same time canting up the other end.

On the other hand by using tie-plates this great vertical force of 11,500 lbs. is distributed over the tie. The small lateral force of 3,442 lbs. is readily taken care of by the friction of the rail on the plate, but more particularly by one inner and one outer spike, or in extreme cases by two outer and one inner. A number of railways, after making careful comparative tests both of rail braces and tie-plates have had such strong practical demonstration of the above facts that they have abandoned the former and adopted the latter.

VERTICAL LIFT LOCK FOR DORTMUND AND EMS CANAL, HEINRICHENBURG, GERMANY.

(With inset.)

A vertical lift lock, possessing several novel features in its construction, has been built to overcome a rise of 16 m. (62.48 ft.) at Heinrichenburg, on the Dortmund branch of the new canal, being constructed to join the Rhine and Ems Rivers in Germany. Except in the height of lift this lock corresponds very closely in size to the proposed lift lock for the Erie Canal at Lockport, N. Y., and in view of the full description of the Lockport structure given in Engineering News, April 18, 1895, it is interesting to study the ideas of foreign engineers in the solution of their very similar problem. As a preface to this consideration it may be stated that in the issue of Engineering News, noted above, the structural features characteristic of this type of canal locks were described and their advantages and disadvantages under different conditions were discussed at length. For the description of the Heinrichenburg lock given here we are indebted to an article in our French contemporary "Le Genie Civil."

The construction and operation of the Heinrichenburg lift lock are indicated in a general way by Figs. 1, 2 and 3. As will be seen, a trough or lock chamber of sheet iron, 70 × 8.6 × 2.5 m. (229.6 × 28.2 × 8.2 ft.) is carried on five hollow cylinders immersed in vertical wells filled with water. The buoyancy of these cylinders when midway of the total rise, 16 m., just counterbalances the superimposed load, which comprises the weight of the cylinders, the metal work of the trough and supporting framework, and the water in the trough. Any increase or decrease, therefore, in the superimposed load tends to cause a vertical movement of the cylinders and lock chamber. To quiet this movement four framework towers of steel are located about at the four corners of the lock cham-

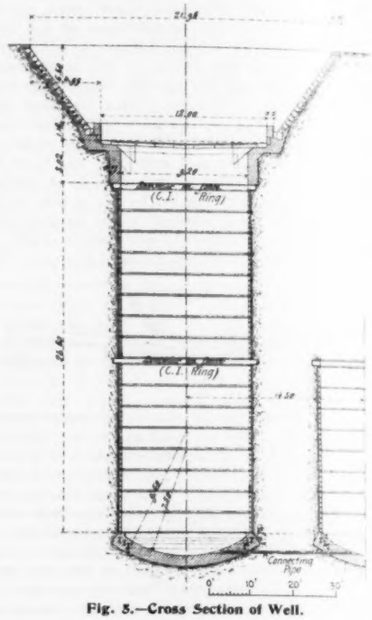


Fig. 5.—Cross Section of Well.

ber, and to regulate the movement as well as to supply the additional force necessary to cause it under certain conditions, four screws are placed, one at each tower.

The mode of operation is evident from the foregoing. When it is wished to pass a vessel into the lock the gate of the lock chamber and that of the corresponding level of the canal are opened. The vessel once being in the lock the gates are closed and the lock chamber raised or lowered, as may be desired, to the opposite canal level. The process of taking the vessel from the lock chamber is similar to that of passing it into the lock chamber. Power for operating the lifting screws, the lock and canal gates, and the capstans hauling the boats, is furnished by a 220-HP. electric plant. With this general explanation attention may now be turned to the details of construction.

In constructing the lock the first work was the excavation of the pit and the construction of the wells. The excavation was on a side hill, but the material was very favorable, being a marl, with occasional seams of rock, but bearing very little water. The surface dimensions of the excavation were 100 × 54.5 m. (328 × 178.76 ft.), which, with the slopes and terrace, Fig. 4, gave 72 × 11.5 m. (235.2×37.7 ft.) as the bottom dimensions of a pit 12 m. (39.36 ft.) deep. The five wells were begun at this bottom level. These wells are 9.2 m. (30.17 ft.) in diameter, each, and were placed 11.5 m. (37.7 ft.) apart, c. to c., in a single row. At the top of each well a ring or crown of concrete was built and at the bottom there was placed an inverted dome or spherical segment of the same material. The sides of the wells were lined with cast-iron rings or cylinders, each 1.5 m. (4.92 ft.) deep. These consecutive rings were screwed together, the hub and spigot ends being threaded for this purpose, and made tight by lead joints. The well construction is clearly shown by Fig. 5, and the nature of the plant used in doing the work is shown by Fig. 4. Altogether seven months were required to complete the excavation and well con-

struction, exclusive of the construction of the passageways connecting the bottoms of the wells. The work was done by the contractors for the lock, Haniel & Lueg, of Dusseldorf, Germany.

Following the well construction, work was begun on the foundations for the operating screws. Four rectangular wells 2×2.6 m. (6.56×8.52 ft.) in lateral dimensions and 10 m. (32.8 ft.) deep were dug and a pier of concrete built at the bottom of each. These piers take the thrust of the screws, which, under certain conditions, amounts to 1,000 tonnes. Simultaneously with the construction of the screw foundations, work was completed on the towers, the nature of whose construction is shown by the illustrations. Each screw was a single piece of forged steel 24.5 m. (80.36 ft.) long, 17.5 m. (24.6 ft.) of which are threaded, and has an outside diameter of 28 cm. (11 ins.). To make certain of the quality of the material a 100 mm. (3.93 ins.) hole was bored the entire length of each screw at the center.

The floating cylinders were built by the Harkort Works, of Duisburg, Germany. Each was 8.3 m. (27.22 ft.) in diameter and 10.275 m. (33.7 ft.) long, outside dimensions, and had cylindrical sides and spherical ends. The material was 18 to 20 mm. (0.7 in. to 0.78 in.) steel plates. Inside each cylinder was a steel framework to give rigidity to the surface plates. Each cylinder carries a tower of steel framework and the tops of all five towers are connected by a bridge which carries the iron trough or lock chamber and gives it the necessary bracing. The trough itself is made of 10 mm. to 14 mm. (0.39 in. to 0.55 in.) iron plates, which are reinforced on the bottom with plates varying in thickness from 8 mm. (0.31 in.) at the center to 16 mm. (0.62 in.) at the sides.

The power for operating the screws is provided by a 150-HP. electric motor located in a cabin at the middle of the bridge connecting the four main towers. From this motor the power is conveyed by the shafts and gears plainly shown by Figs. 1, 2 and 3. The speed of travel given to the lock chamber by this machinery is 10 cm. (3.937 ins.) per second, making the time necessary to pass a boat through the lock 15 minutes altogether. An independent motor of 100-HP. operates the lock gates.

The foregoing description and illustrations give a very fair idea of the Heinrichenburg lift lock. No figures of the cost of construction are available nor is information yet available regarding the success of its operation.

IMPROVEMENT TO THE WATER SUPPLY OF YORK, PA.

One of the earliest towns in the United States to enjoy a public water supply was York, Pa., where works were built in 1816 by the York Water Co. What parts of the old works, if any, are still in use, we cannot say. Just now the works are being improved by the addition of a pumping station and storage reservoir, with the necessary force and supply mains.

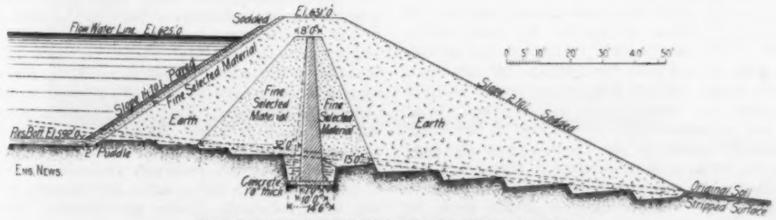
The pumping station is located on Codorus Creek, across which a crib dam has been built to raise the water 5 ft. and supply the pump well. The pumping plant includes two Campbell & Zell boilers, designed for an actual horse power of 350 each, and two 5,000,000-gallon horizontal triple expansion, high duty, Worthington engines. The main engine and boiler room floor being 6, and the basement floor 14 ft. below flood level, the entrance and all other openings are kept above that level to prevent flooding. There is a gallery floor at the entrance with steps down to the main floor.

The pumps work under a pressure of 150 lbs., delivering water through a 24-in. cast-iron force main, about 11,000 ft. long. This main passes over four hills and at the summit of each is an air vent consisting of a 24×8-in. T-branch, surmounted with one length of 8-in. pipe, properly protected at the opening.

The reservoir has a capacity of about 40,000,000 gallons. It is built in two compartments, is located on a hillside, and is formed by a curved embankment somewhat resembling a horse-shoe in shape. A section through the main embankment is shown by the accompanying illustration.

The force main extends over the top of the embankment, instead of through it. There are two gatehouses, one at the adjoining corners of the two basins, arranged so as to draw water at two different levels, from either or both basins. The other gatehouse is at the foot of the outer slope, and controls the supply in either of two directions, or permits the emptying of the reservoir through the one outlet pipe. A new 20-in. supply main will lead to the city. The reservoir has an overflow into a ravine through a culvert.

We are indebted to Mr. Chas. A. Hague, M. Am. Soc. C. E., of 39 Cortlandt St., engineer for the improvements, for the information given. The contractor for the pumping station, reservoir, force and supply mains was Mr. John Berkery, of New York city and West Hoboken, N. J. Mr. J. L. Kuehn is superintendent of the York Water Co.



SECTION OF RESERVOIR EMBANKMENT, YORK, PA.
Chas. A. Hague, M. Am. Soc. C. E., Engineer.

THE RAILWAYS OF THE UNITED STATES IN 1895.

The introduction to the yearly volume of Poor's "Manual of Railways" always contains a summary of the statistics of the railways for the preceding year, and we give below an abstract of these statistics, taken from advance sheets of this introduction for the volume for 1896, which is the 29th annual number. The statistics are for the year 1895, and the book is issued somewhat later than usual, for which three reasons are given: 1, an increase of 300 pages in size; 2, the delay occasioned by printers quitting work for more than two weeks during the recent hot spell; and 3, a loss of over two weeks on account of a printers' strike. The total mileage of railway on Dec. 31, 1895, was 180,955 miles, only 1,627 miles having been built during the year, as against 2,157 miles in 1894. The statistics cover practically all the railways, only 659 miles being given as "not reporting." The figures for these 179,821 miles of railway may be summarized as follows:

Capital stock	$5,182,121,999
Funded, unfunded and current debts	6,488,779,615
Total liabilities	$11,670,901,614
Cost of railway and equipment	$9,861,102,973
Real estate, stocks, bonds & all other assets	2,168,421,392
Total assets	$12,029,524,365
Excess of assets over liabilities	$358,622,751
Train mileage, passengers	327,204,734
" " freight	491,410,820
" " mixed	15,457,939
Total revenue train mileage	834,163,493
Passengers carried	543,974,263
Passenger, mileage	12,642,202,551
Freight moved, tons	763,799,883
Tons of freight moved one mile	88,567,770,801
Earnings, passenger	$261,640,598
" freight	743,784,451
" other	87,714,556
Total traffic revenue	$1,093,139,605
Operating expenses	$769,943,151
Net earnings	323,196,454
Rentals and other receipts	113,768,075
Total available revenue	$436,964,529
Payments from available revenue:	
Interest on bonds	$239,944,229
Other interest	8,191,655
Dividends	81,375,774
Rentals, tools, etc.	68,885,266
Miscellaneous	33,404,887
Total	$431,801,811
Balance	$5,162,718

A comparison with the general results of operation in 1895 and in 1894 are given in the following table, from which it will be seen that the differences are very small, but are encouraging as compared with 1894, for which purpose we have added the last column of the table, showing the percentage of increase and decrease of 1894 over 1893. In 1895 the freight traffic increased 11.72% over 1894, but the earnings from freight only increased 6.18%, while the passenger traffic and earnings show a decrease.

	1895.	1894.	Increase or decrease.	P. c. of increase or decrease, 1895.	P. c. of increase or decrease, 1894.
Miles of railway operated	179,162	176,229	+ 2,933	+ 1.66	+ 1.19
Tons of freight moved	763,799,833	674,714,747	+ 89,085,086	+ 11.72	—10.85
Freight mileage	88,567,770,807	82,219,900,498	+ 6,347,870,303	+ 7.72	— 9.12
Passengers carried	543,974,263	583,248,007	— 39,273,744	— 6.73	— 7.25
Passenger mileage	12,642,202,551	13,600,531,635	— 958,329,084	— 7.05	—10.20
Earnings, freight	$743,784,451	$700,477,409	+ 43,307,042	+ 6.18	—13.36
" passenger	261,640,589	276,031,571	— 14,390,973	— 5.21	—11.52
" miscellaneous	87,714,543	91,134,533	— 3,419,990	— 3.75	+ 3.36
" gross	1,093,139,605	1,067,643,513	+ 25,496,092	+ 2.39	—11.64
" net	323,196,454	317,757,399	+ 5,439,055	+ 1.71	—11.53
" per ton per mile, cts.	0.839	0.864	+ 0.025	+ 2.89	— 4.70

A statement prepared with a view to ascertaining the relation borne by the great trunk lines of railway to the entire railway system of the country shows that 59 railway systems control more than 61% of all the railways in operation. Of the passengers carried in 1895 (543,974,263) these 59 systems carried 386,625,325, or 71%, a total distance of 9,686,080,240 miles at an average charge of 2.016 cts. per passenger per mile, against a general average of 2.069 cts. for all the railways of the country. Of the freight tonnage they hauled 60%. Their aggregate haulage equalled 67,268,068,380 tons one mile, being 76% of the grand total, while the average charge per ton per mile was 0.834 ct., or 0.015 ct. less than the general average for the whole country.

The street railway statistics may be summarized as follows, but it is stated that many companies have furnished very meager information. The rapid substitution of electric traction for horse power may be gathered from the fact that since 1891 the number of horses employed in this service has decreased by 162,000, or about 80%.

Total mileage of track	15,956
Capital stock	$828,547,285
Bonded debt	$525,949,928
Mileage of electric lines	13,556
" of cable lines	612
" of horse lines	1,351
" of dummy lines	384
No. of horses and mules	28,154
" of dummy engines	206
" of motor cars	20,777
" of passenger cars	28,621

On the steam railways the average haul was 23.24 miles per passenger and 115.96 miles per ton.

	1895.	1894.	1895.
Miles of steel rails	98,102	196,653	205,546
Miles of iron rails	62,495	35,266	28,652
Miles of track	160,596	232,919	235,198
Per cent. of steel rails	61.0	84.8	87.8
No. of locomotives	25,937	26,784	27,090
No. passenger cars	17,290	27,021	27,970
No. bag'ge, mail and exp. cars	6,044	7,921	7,801
No. freight cars	805,519	1,288,790	1,230,617
No. of all cars	828,853	1,264,641	1,266,087

THE INVENTION OF THE ART OF LITHOGRAPHY, by Alois Senefelder, in Germany, in 1796, is to be celebrated in New York on Oct. 16 and 17. This celebration will take the form of an exhibition of all the different products of lithography, including prints from the earliest date and from all countries. Lectures upon the history and progress of this art by experts will also be given. Any one who can aid the committee in this laudable work by loaning specimens in their possession or by suggestions should communicate with the chairman, Mr. Joseph R. Keogh, 23 Third Ave., New York city.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The development of rail sections has always been an interesting subject for railway engineers and rail manufacturers, as in the early days of railways each engineer wanted to have a special section of his own on his own line, and each man had his own particular hobby as to rail sections. Within recent years a very close concensus of opinion has been reached as to the forms and proportions of rails, but on the less important branches and portions of many railways of any considerable age there are to be found various types of sections now obsolete. The development of the form of section on such roads is particularly interesting since it shows the changes that have been introduced under similar conditions, and in another column we give a set of the eight sections which have been used on the Denver & Rio Grande R. R., beginning with a 30-lb. rail in 1871, when the road was first commenced, and ending with an 85-lb. rail, which has been laid during 1895 and 1896. The oldest rails were of peculiarly round-headed section, showing evidently the influence of English practice, but more curious still are the two sections in which the sides of the head flare inward from the top, a form of section which was designed from wrong ideas and was but little used. The present rail section conforms practically to the type recommended by the committee of the American Society of Civil Engineers, except that the top corners appear to be of larger radius, while the sides of the head, instead of being vertical are slightly flared outward from the top. This latter practice is followed by a large number of railways, and is incorporated in the Dudley patented form of section now so extensively used. The set of sections which we illustrate in comparative form is a good example of the history of rail sections on individual railways in this country.

While the tie-plate is a decidedly modern invention it has already fully borne out the ideas of its designers and is now very extensively used, while its application is spreading very rapidly. Briefly this device consists of a metal plate interposed between the rail and the wooden tie, its purpose being to protect the wood of the tie from the cutting and abrading action of the rail, which action is more influential than any other in causing the destruction of the tie and rendering tie renewals necessary. The tie-plate is thus a species of tie preservative or protector, and is not to be classed with the old chairs and joint chairs whose office was to support the rail and hold it in position. It would seem at first glance as though such a simple thing as a tie-plate would not require much designing, and would not call for much theoretical consideration of the forces it has to sustain, but as a matter of fact, while the tie-plate is a small and simple thing enough in itself yet its efficiency may be very greatly increased by a little care in designing it with due regard to the work it is required to do. That this is so will be clearly understood from the perusal of a paper in another column. The manufacture of tie-plates is now one of the most important industries in the railway supply business, and while almost any form of plate is an improvement over the direct contact between rail and tie, yet it may readily be seen that there are opportunities for increasing the practical efficiency of the plates. The main objection to a simple flat plate is that it is impossible to keep it tight, so that there will be a continual movement of the rail on the plate and the plate on the tie, with a consequent admission of dust and moisture to cause wear and decay, and also a consequent clattering under traffic. Besides this, if the plate is thin and wide it will bend and buckle, while if made sufficiently thick to resist bending the plate will be clumsy and expensive. The question then is, how to secure a permanent connection between the plate and the tie, and this appears to have been most efficiently attained by making a plate with longitudinal ribs or flanges which sink into the fibers of the wood and are tightly held by them, while the size of the flanges is not such as to crush or split the wood. These flanges also serve to stiffen the plate and enable a thin plate to be used without buckling under heavy loads. The use of the tie-plates not only effects an improvement in the track, but also (at very little expenditure) effects a reduction in the expenses of track maintenance, since it enables soft and cheap durable timbers to be used for ties, as the timber is protected from the cutting action of the rail, and such cheap ties thus protected may actually last longer (and be thus more economical) than more expensive hard woods not thus protected.

The substitution of cable for horse-power on surface railways, and the consequent increased speed, reduced operating expenses and better service, certainly seems to pay in New York city, as is indicated in several directions. The Broadway cable-line, in its first year of operation, reported to the State Railroad Commission a gain of 25% in total traffic and a decrease of 20% in operating cost, or a total gain of 45%, as compared with the operation of this line by horse-power in the year preceding. The actual gain in passengers carried since then is not now at hand, but the Third Avenue cable-line was opened on Dec. 4, 1893, and the official figures for the year ending June 30, 1894, show a gain of nearly two million passengers carried over the average for the three previous years, though this report would include only about six months of cable service. How much loss of traffic might be charged to the delay in operation caused by the change from one system to the other it is impossible to state; but the undoubted and sudden increase in passengers after the cable was completed would seem to prove that the change was a popular one. That some other lines of traffic suffered by the changed conditions on these two cable surface roads is indicated in the lately published report of the Manhattan Elevated Railway Company to the State Railroad Commission. The report of this parallel and competing system is made up to June 30, 1896, and shows that the "total income" of elevated roads has steadily decreased since 1893, when the cable system practically came into competition. In this period the Manhattan has made considerable effort to maintain its traffic, and the growth of population in the northern section of the city has certainly not decreased. But the advantages of more rapid transit on surface roads, with no stairways to climb and somewhat less travel from the centres of traffic, has certainly had an effect upon the number of passengers formerly using the elevated system. The fact of the matter is that the cable surface roads are not only catching the short-haul passengers, but also many riding for long distanecs, who find the surface lines more convenient for their purposes and now fast enough to use.

Cuban, or rather Spanish methods of estimating upon and contracting for the execution of public works in that island are peculiar, to say the least. In a paper lately presented to the American Society of Civil Engineers, Mr. E. Sherman Gould, M. Am. Soc. C. E., describes the new water-works of Havana, and incidentally treats of the contract system prevailing there. After the preparation of the plans, an estimate must be made, down to the most minute details of the exact quantities of each class of work required. These plans, estimates and quantities, accompanied by a report, must then be submitted to the home government for approval; and after such approval any radical change found necessary during construction must first be submitted to the Cuban authorities, then to the home authorities, and a royal order obtained before anything can be done. While this may seem necessary, under the "paternal" form of government assumed by Spain towards its colonies, it is likely to be embarrassing to both engineers and contractors and certainly does delay execution. But another and seemingly very useless and objectionable feature of the system is the requirement that in quantity and cost each class of work must stand by itself. Consequently, if in the execution of the work any quantity, and, of course, the resultant cost, should fall short of the submitted estimate, this surplus is not available to make good any excess of quantity and cost in another piece of the same work; but a new appropriation for "extra work" must be carried through the network of red tape referred to, though there is actually an unexpended balance on hand. Another rule, which holds good in Spain as well as in Cuba, is that acceptance of the contract, after an examination of the plans and documents, makes the design virtually the contractors, and the contractor and not the engineer is responsible for all failure that may result from the plans. The only loop-hole of escape for the contractor is the filing of a written protest before commencing any work in which he deems the plans insufficient.

This system is certainly ingenious in its complicated difficulty, its multitude of authorities, enforced delay in execution, and in its disregard of the many contingencies which may make necessary some radical change in plan during the progress of the work. But it also indicates the tenacity of Spain's grip upon her colonies and how little she trusts them to attend to their own business. The proviso for shifting responsibility for the failure of plans, from the engineer to the contractor, reflects rather badly upon the confidence a Spanish engineer seems to have in the sufficiency of his own designs. And Mr. Gould shows in his paper that the original plans for part of the Havana work were insufficient. This reservoir was to be covered with groined elliptical arches of cement that were to rest upon granite columns made of three separate blocks of stone. The execution of this work was so difficult and almost impossible that the reservoir remains uncovered to-day, and plans for a safer and simpler covering were rejected. Under the peculiar Spanish laws regarding responsibility for plans, this failure to cover the reservoir must be charged to the contractor.

The use of springs for sources of public water supply is quite common in some parts of the country, notably in New England. The conditions governing the yield of springs have not been so carefully studied as those relating to surface sources. The reason for this, apparently, is that most springs have been utilized in this country where only comparatively small quantities of water are required. One or more springs have been piped to towns at the outset, and others have been added later, or other sources of supply sought, as the demands for more water arose. But even where only small water-works are to be supplied prudence demands that

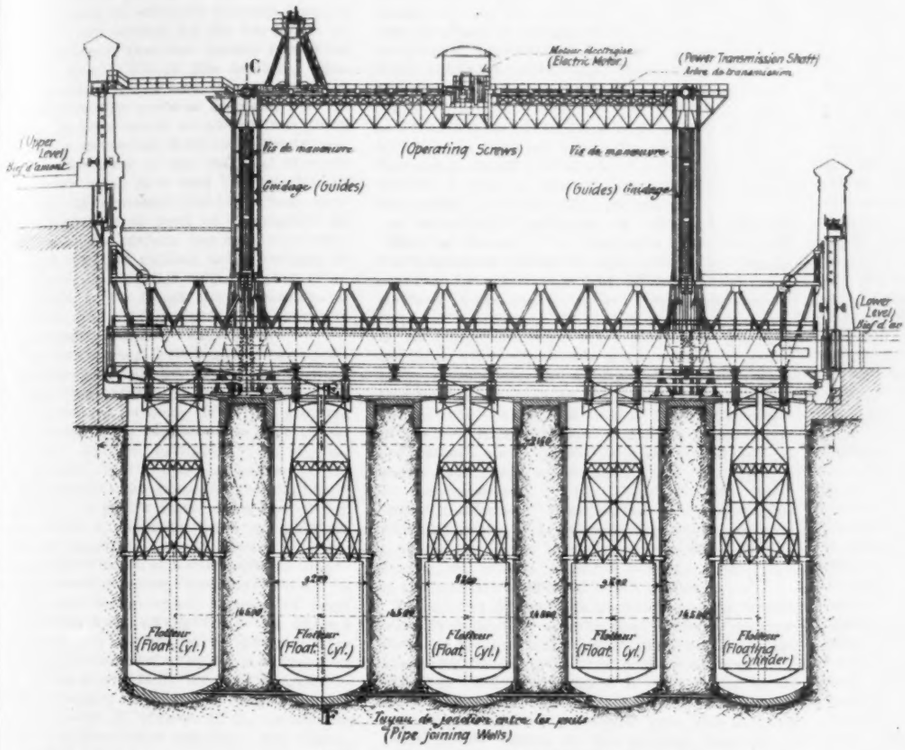


FIG. 1. LONGITUDINAL SECTION A-B.

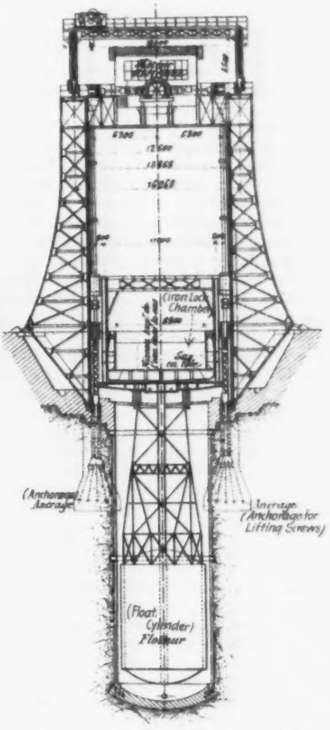


FIG. 2. TRANSVERSE SECTION C-D-E-F.

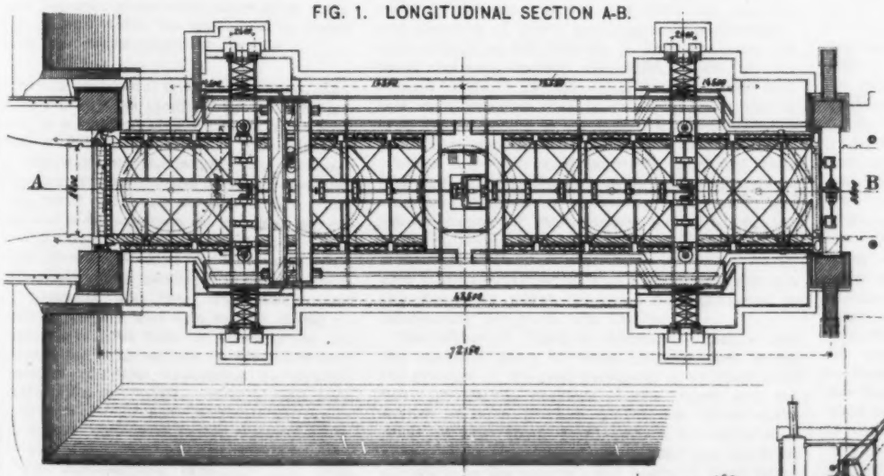


FIG. 3. PLAN.

VERTICAL LIFT LOCK FOR THE DORTMUND AND EMS CANAL; HEINRICHENBURG, GERMANY.

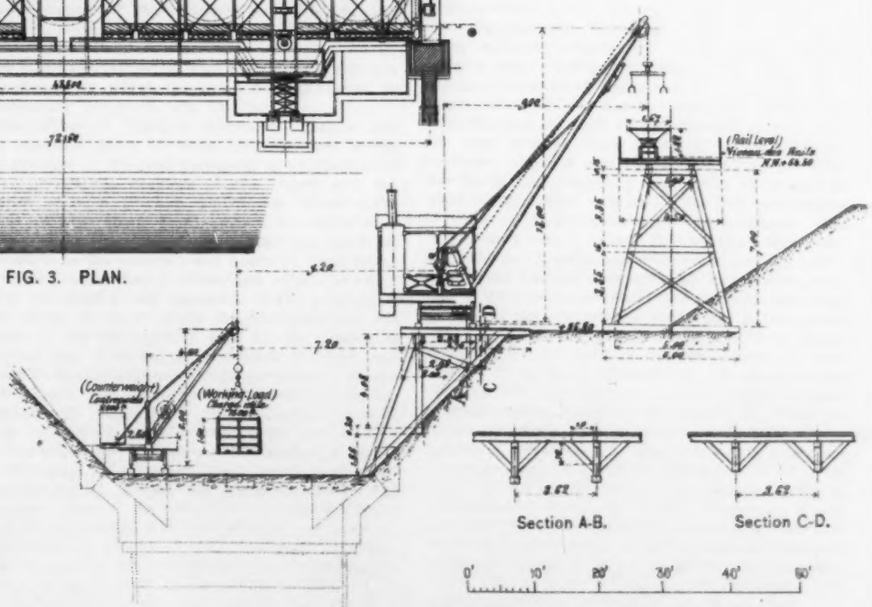
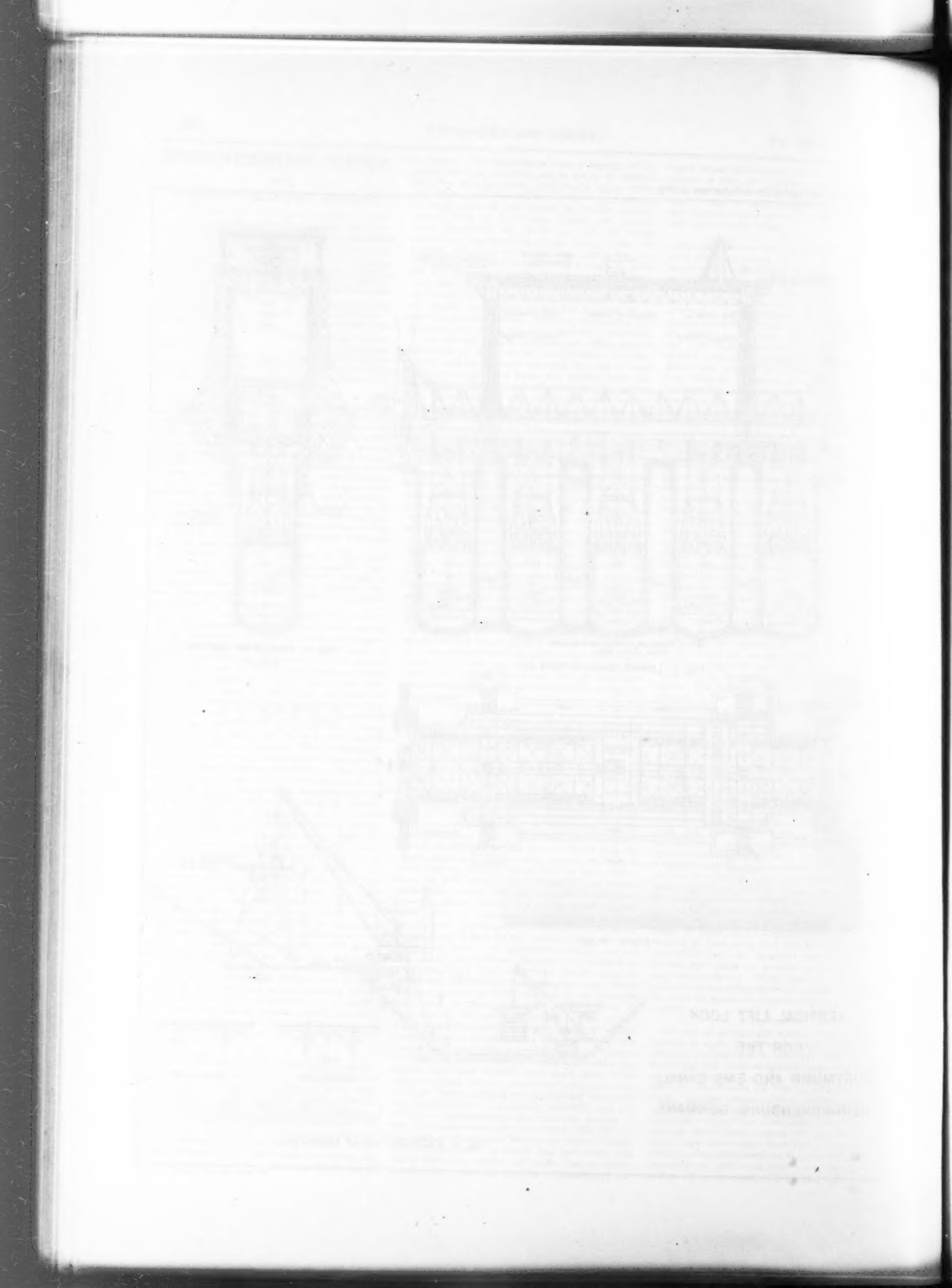


FIG. 4. CROSS-SECTION OF EXCAVATION.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.



the available yield from a spring, or springs, shall be determined as nearly as possible, before adopted as a source of supply. The most obvious and common method of determining the yield is to make a gaging of the flow from the spring, but a single gaging, or a season's gaging is not sufficient to determine what may be expected through a series of years, even when backed by the assurance of the "oldest inhabitant" that the "spring was never known to run dry." Where the drainage area tributary to a given spring and the rainfall of a locality are known, the problem of yield, year in and year out, is very much simplified, but there still remains the governing geological conditions, especially the character of the material through which the water must flow and the relation of permeable and impermeable strata. These geological conditions may in part be determined by an examination of the surface, but cannot be completely learned without putting down borings or test pits. When all else has been decided there will still remain to be found the percentage of rainfall lost by run-off, by surface evaporation and by plant absorption and evaporation.

So far as we know, very little has ever been published regarding the available yield from springs. Far more has been printed on the yield of wells, a very closely related subject. With the growing demands for pure water supplies, the yield of our mountain and hillside springs, ever popular sources of supply, will become a matter of increasing importance, for however thoroughly it may be possible to purify water most people will prefer that which is naturally pure. In addition, a public water supply is already almost a necessity for the small villages of a few hundred inhabitants, and in some sections these may obtain, as many already are doing, ample supplies of clear, cool and sparkling water at slight expense, where a water purification plant might be considered as entirely out of the question, even if not actually so.

In view of the above facts we give a considerable amount of space elsewhere in this issue, to a paper by Mr. Louis E. Hawes, C. E., on springs as sources of public water supplies. Mr. Hawes has brought together some very interesting matter on this subject which we commend to those interested in the development of springs.

The practically successful trial, at Portland, Me., of the Hargrave kite, as modified by Mr. Charles H. Lamson, is a marked step forward in solving the solution of aerial navigation. This kite, or aeroplane, was not only the largest ever successfully floated, but it also carried aloft the heaviest weight ever lifted with any similar device. Unfortunately the press accounts do not give the dimensions of Mr. Lamson's kite, other than to state that it took 15 men to carry it. The interesting point in the experiment, however, is the fact that a dummy weighing 150 lbs. was safely and steadily carried by this kite to a height of 600 ft. At this point a sudden gust of wind broke the retaining cord; but after sailing on for about half a mile further the kite descended as steadily and as easily as it ascended. Had a man been upon the kite he would have suffered no injury whatever. Those interested in Mr. Lamson's experiments may see a full account of his smaller kites in "The Aeronautical Annual," for 1896, edited by Mr. James Means, of Boston, Mass. This air-ship is practically made up of two rectangular cells, open at the parallel sides of the longest dimension. Each cell is jointed, or hinged, near the front and back ends, and these smaller hinged cells can be manipulated by levers so as to change the vertical direction of flight. Lateral steering is accomplished by shifting the weight to either side of the center, the vessel turning towards the loaded side. It should be explained that these two main cells are parallel to, but at some distance from each other, being connected by a light and strong framework. In the original kite there are no wings, or movable parts, other than the hinged ends of the main cells; and the especial features of this form of aeroplane are great steadiness in flight and unusual lifting power. The absence of intricate moving parts is especially advantageous, coupled with the general simplicity of form and construction, and further development on these lines will be awaited with interest.

GERMAN EXPORT METHODS.

In our issue of Aug. 13 we commented upon the growing interest in the United States in an increased export of our own manufactures and we also noted the more prominent American organizations now engaged in activily promoting the extension of this foreign trade. In connection with this proposed development of a practically new business it is profitable to study the methods of other countries which have resulted in commercial success, and among these other countries Germany is just now taking a very prominent place as a manufacturing and exporting nation. Methods which have built up a rapidly growing trade in German goods all over England, until lately almost without a rival in manufacturing for the rest of the world, are worth close attention.

A book lately published in England, entitled "Made in Germany," is creating a stir among the manufacturing classes in that country by bluntly proving, by statements and official figures, that England is fast losing her old position as the undisputed mistress of the world of commerce, and is no longer supreme even at home. The law requiring all foreign-made goods sold in England to be plainly marked as "made" in some other country, is having an unexpected reactionary effect. It is opening the eyes of British manufacturers and those interested in British industries to the present and rapidly increasing volume of goods "not made in England" and yet supplied to the consumers of that country. The label, "made in Germany" is appearing on a dangerously widening group of goods, and this means not only a shrinkage in the home market to English producers, but it also implies a perilous competition in the markets outside of Great Britain.

The author of the book quoted shows by figures from Parlimentary reports, that while the proportion per head of exported English products was about $40.24 in 1872, this proportion was only $27.70 in 1894. A reduction in the price of goods exported may account for a part of this decrease, but further figures presented give another and more potent reason in the German increase of trade in the same period. In 1883 the imports into England of goods manufactured in Germany were valued at $83,150,000; in 1893 the value of these German imports was $128,150,000, an increase of about 30 per cent. in ten years, and this in a country that in the near past had a practical monopoly in the supply of manufactured goods to a large part of the trading world.

While American manufacturers may not view this reduction in English trade with any overwhelming amount of sympathy and regret, the alleged causes of this decrease have a direct interest to them in any attempt to extend the introduction of their own products into other lands. And quite as interesting and worthy of study are the means by which Germany has succeeded in introducing her goods into England.

The author of "Made in Germany" frankly tells the manufacturers of Great Britain that under the prestige of the past monopoly of all trade they have grown too careless of the wants and demands of even English consumers. They make what pleases them best; adhere to out-of-date methods, designs and processes; and pay too little attention to the comfort and needs of their labor, a neglect which has a direct and injurious effect upon the quality and character of the product of this labor. In short, while the manufacturer has stuck to the rut marked deep by the wheels of another age of trade, the consumer is being educated to the advantages and possibilities of a more enlightened and intelligent treatment of an old subject. To make plain our meaning, we have only to contrast some of the commonest articles of household use as made in England and "made in Germany." In the one case we too commonly find old forms, clumsy and inartistic design and careless finish; in the other there is very generally a grace, lightness and beauty that can only result from careful study and intelligent attention paid to the minute details and the actual needs, use and appearance of the product, whatever it is. When this better and handsomer article is offered in the market for the same, or often at a lower price, it is not remarkable that the consumer will prefer it and buy it and that his neighbors will gradually do the same.

A late editorial in London "Engineering," treating of the rapidly growing competition of Germany and the United States with England in the Australian trade, incidentally illustrates the indifference of some English manufacturers in attending even to the wants of home customers. It seems that a prominent firm of engineers applied to a famous English tool-building establishment for some suggestions in the improvement of a certain class of machines which would tend to increase their output; and the application was coupled with the promise to purchase all machines from this firm if any substantial gain could be shown in the product. The tool-makers in question sent an aged foreman to look into the matter and he proved to be quite incapable of giving any advice of value. In despair, a German firm was then applied to with quite a different result. A bright young German engineer was at once despatched to the works in question who carefully and intelligently examined the machines in use, sent samples of the finished product to Germany and had the whole matter investigated by competent men there. The outcome was that the German firm supplied machines under a guarantee of saving effected that was much surpassed by the actual working of the tools themselves; and England lost what promises to be a very profitable trade. "Engineering," very properly, charges this English establishment with "sheer crass stupidity," but goes on to say that the workmen are to blame as well as the masters. With the object of keeping as many of their members employed as possible the trade societies resent the introduction of labor-saving machines as an injury; and Mr. Maxim relates that for months after the introduction of a special milling tool for machining parts of the Maxim gun, the men insisted upon taking as long to put the finishing touches to this part, after leaving the machine, as if the whole had been done by chisel and file. A German workman who could not speak English was finally put to work, and he accomplished six times as much work in one day as the Englishman did in 1½ days. These British workmen have yet to learn a fact well understood in American shops; and that is that one man can attend to more than one machine, and that experience shows that an increased and cheapened output usually so affects the demand that more, and not less hands are employed as the result of using labor-saving machines.

The cause for the success of Germany in England and the present rapid spread of German goods into English colonies and into other centers of trade once monopolized by England, is not a thing of yesterday, though the effects are only now being seriously felt. For fifty years or more Germany has been slowly but surely fitting herself to be a great industrial nation, by perfecting her system of technical education, now probably the most perfect in the world. She has studied the progress and methods of every other nation and she has trained men to improve upon these methods; she has sent her agents to all parts of the world that promised trade, and these agents have learned what will and what will not be acceptable to the prospective foreign consumer. She has trained men to extend this trade by establishing schools of trade and commerce, and by tabulating and making accessible all information that can be gathered concerning the products and conditions of the commercial world. She is in a position to meet the demands of other nations better than her old competitors, simply because she has studied them more intelligently. As showing the spirit which animates some of the larger German manufacturing concerns the author of "Made in Germany" notes that one German chemical establishment employs no less than fifty chemical specialists; not in the daily inspection of the products of this establishment, but engaged solely in experimental work and in the attempt to devise new and more economical processes of production. This, says our author, would be regarded as sheer waste of capital by the average British manufacturer; but he also notes that this particular German company pays dividends of 25 per cent.

While Belgium was the first of continental nations, in fact the first among nations, to establish a specially equipped school for the commercial training of young men, Germany soon followed,

and has improved upon the Belgian methods. In these schools the study of languages is made a strong feature, and the student is compelled to carry on an "office correspondence" in German, French and English, and he must also select and be proficient in one other language, usually Spanish, Italian or Dutch. He is obliged to study the geography of foreign countries, their history and commercial conditions, and well-filled museums make him familiar with the vegetable, mineral and animal products of other lands. When to this early training is added the progressive spirit that seems to animate every workshop and counting house in Germany, and the wise liberality that is constantly furnishing the means for deeper experimental research into all that might benefit trade, it is little wonder that Germany is making herself felt as an industrial factor.

In this matter of languages the American manufacturer and his agents are notoriously weak, and before any marked success can follow in the extension of our foreign trade we must pay more attention to this important factor. As one of our consuls lately remarks, in discussing prospective trade with the South American States, no American maker of mining machinery would send as his representative to Cripple Creek a Russian wholly unacquainted with English; but the same man will distribute English catalogues among a Spanish-speaking people and send there a man who can only do business through an interpreter. As showing the part familiarity with a language plays in trade, the same consul notes that the United States does more business with 5,000,000 Canadians on its northern border than with the 14,000,000 Mexicans immediately to the South, or in fact with the 35,000,000 Spanish-speaking people in Central and South America. For trade purposes this population is as remote to the average American manufacturer as is China, simply because he does not know them nor their tongue and has not studied their needs and the possibilities of trade. Other nations have been wiser, or went there better equipped and they practically take business from our own doors that naturally belongs to us, and would be ours did we but meet the requisite conditions.

The secret of Germany's commercial success seems to be a careful and intelligent study of the best methods of manufacture and of the conditions, needs and prejudices of the trading world. As before remarked, she has long been preparing herself for the industrial war she is now waging by the technical education and commercial training of her young men. In methods of manufacture and in quantity, character and relative cheapness of products, American manufacturers need take no lessons from Germany; but they can profit by the manner in which Germany has sold her goods outside of her country and in properly equipping men to do this work. It would require a generation of time and a large expenditure of means and effort to accomplish this training by means of commercial schools. But the fact remains that to accomplish the task which many of our manufacturers have now set themselves, proper tools must be used, and the traditions of the past, applicable only to a home market, must be thrown aside. In this connection the several American organizations referred to last week are doing good work by making our manufacturers better acquainted with the conditions and possibilities of trade with other nations. This knowledge is a first requisite, but a second and all important one is the choice of proper agents and of effective methods of taking advantage of the possibilities uncovered. Here these organizations need the active co-operation and moral and financial support of every American manufacturer. And when this broad interest is once awakened we doubt not but that the means will soon be found for educating and supplying the required agents.

LETTERS TO THE EDITOR.

The Section of Electric Railway Tunnels.

Sir: In regard to the much-discussed question of the necessary sectional area in railway tunnels in cities, some late experiences on the Budapest underground railway give endorsement to the unusual dimensions adopted in Boston. The Budapest section was based upon the London tunnels; but it is found to be a great mistake to have two tracks in such a small tube. The ventilation is very bad and the air pressure is a serious trouble to the traffic, and, as experience proves, there may be other reasons for more liberal dimensions.

In one day lately the following accidents occurred on the Budapest railway: (1) A workman in stepping from one track to avoid a train was killed on the other track; (2) A conductor, leaning out to ascertain why the motorman was ringing the bell, was badly injured; (3) A car was set on fire in the tunnel by an accident to the grip-conduit and the six passengers only escaped through the coolness of the men on the burning car and the following car, the latter car being used to push the first rapidly out of the tunnel. Both motormen were badly injured. Some time ago an accident to the grip practically imprisoned in the tunnel, for some time, the Austrian Minister and a number of invited guests.

It is rather surprising that such accidents should occur in the operation of an electric underground railway; and they may be exceptional experiences that will not occur again in regular service. But the fact remains that they do happen; and it is evident that more room is necessary in the tunnel than just enough to pass the cars.

Yours truly, Fr. von Emperger.

Carlsbad, Bohemia, Aug. 2, 1896.

The three underground electric railways of London (one in operation, one nearly completed and one just commenced) are all designed with a separate tunnel, of circular section, for each track.

The Budapest tunnel is rectangular, 19.7 ft. wide and 9 ft. high, with a row of columns in the middle. The Boston subway is also rectangular, 24 ft. wide and 15 ft. high, without a central row of columns, except on the four-track section, where the columns support the roof of a tunnel section 48 × 15 ft.—Ed.

Pooling Freight Equipment.

Sir: Referring to the editorial on my paper on the subject of "Pooling Freight Equipment," in your issue of Aug. 20, I am glad to have your expression on this matter, as "every little helps," and I am satisfied that the proposed scheme will effect a saving in expenses to railways of many millions of dollars per annum, as well as increase their earnings.

I note your remarks relative to a contemplated objection of putting equipment owned by "car trusts" into the pool. I do not see that this will make any difference for the reason that the trust cars will receive their prorata earnings according to their valuation in the pool and they will receive greater earnings on their equipment than at present; so it is to their interest to join in the proposed Co-operative Equipment Co. Yours truly,

Jos. R. Cavanagh,
Supt. of Car Service, C., C., C. & St. L. Ry.

Indianapolis, Ind., Aug. 28, 1896.

The Preparation of Bridge Specifications.

Sir: Your editorial on "Who should prepare specifications" is a very timely and valuable paper. If the suggestion contained therein, "that the engineer should consult with and profit by the experience of those whose province it is to carry out in practice the ideas which he originates," be followed it would inevitably lead to that most desirable end, a uniformity in best mill and shop practice. A uniformity of practice for the same grade and character of work and not a uniform specification for all grades and characters, without due regard for special duties, etc.; this latter would be manifestly unwise and unnecessary. Under the present method of each consulting and chief engineer preparing his own specification, incorporating his own particular hobbies, without regard to present practice, final costs or results, the manufacturer is compelled to work to numberless requirements; and in one bridge office there are to be found on file 60 different specifications for bridges alone. These special ideas often make it necessary to entirely change shop methods and practice, increasing cost, without any corresponding increased value or efficiency. Every manufacturer has had this experience.

It is with no desire to infringe upon the field of the consulting engineer and chief engineer that manufacturers prepare and publish specifications covering what they believe to be best practice in their specialties. Manufacturers and engineers should work together, and these specifications are prepared for the assistance and guidance of engineers in general practice, who have not the time or opportunity to give all the details of manufacture of each specialty the attention and study which are necessary to prepare a proper specification.

It would be very poor business wisdom on the part of any mill or shop, which cares for its reputation, to send out amongst its clients a specification which could be shown to call for poor grade of material or poor workmanship. I, of course, understand your remarks and suggestions as only referring to those manufacturers and engineers who have a pride in their work and name, are above any mere money getting, and who are continually trying to improve upon past practice, not only from their own experience but the experience of others in the same line. It would be useless to address those who resort to tricks and "wire pulling" to obtain business. Their practice is anything found necessary for the time being.

The field of work of the consulting engineer and the chief engineer of a railway or company is one which cannot be covered by the manufacturer; their work is mainly done before the contract comes before the manufacturer; they study the work in hand in all its bearings and relations, crystallize it into shape, fix the general requirements and divide it under its several classes of special work.

The contract is then in shape to be sent to specialists for prices. These special and detail specifications should not be prepared without conference with manufacturers unless the engineer by special training is entirely familiar with every detail of the work. If the letting can be confined to reputable concerns, it is desirable to give the manufacturer the opportunity of giving the engineer the benefit of his special experience and practice, not binding him to unimportant details at every point. The engineer is simply interested in final results; if these are up to his requirements and standard he should be satisfied.

In recent years there has been a tendency amongst parties who have work in view not to employ the consulting engineer or chief engineer, thinking to save this small expense, but to go direct to the manufacturer. This is poor judgment and a very unwise practice; it throws extra expense into every competition which the buyer must ultimately pay for; he will probably accept the cheapest bid made to him, and as the manufacturer has had no opportunity of judging of the merits of his design in connection with the surrounding conditions, it may be a very bad selection and cost more in the end. Engineering work of any magnitude should have the benefit of the disinterested investigation of a consulting engineer and the general features at least should be determined upon, before it is referred to the manufacturer. The practice above referred to is being discouraged more and more by the more reputable concerns, as it is not to their interest to do consulting work and they welcome heartily the supervision of any able and competent engineer and are glad to work to his requirements and specifications.

John Sterling Deans,
Chief Engineer, The Phoenix Bridge Co.

Phoenixville, Pa., Aug. 26, 1896.

SECTION OF WHEEL AND RAIL; C., M. & ST. P. RY.

While probably a majority of railways in this country have adopted the M. C. B. standard section for carwheel tread and flange, this section is not universal, and the Chicago, Milwaukee & St. Paul Ry. has modified the section in such a way as to greatly reduce the flange wear. This section is shown herewith, together with the section of the head of the standard 75-lb. rail of the same road.

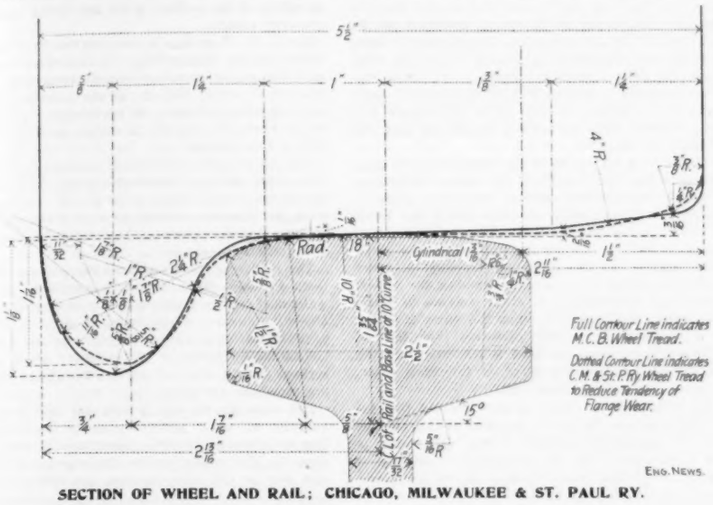
We are indebted to Mr. J. N. Barr, Superintendent of Motive Power, for a blue print, showing the C., M. & St. P. Ry. and M. C. B. sections of wheels, and we give below the remarks made by Mr. Barr at the recent convention of the Master Car Builders' Association, in discussing the question: "Is the present M. C. B. standard shape of wheel, tread and flange the best that can be designed for service."

I have a blue print here on an enlarged scale, which reveals the fact that our present adopted dimensions won't go quite together. You have to squeeze them a little bit. In the present standard the fillet in the throat is $\frac{5}{8}$-in. radius. We took and started from the center line of the rail with a 10-in. radius, gradually decreasing the radius to $\frac{1}{2}$-in., and that gained in the throat, as shown in the difference between the dotted and full line, quite an amount of metal to wear off. In addition to that we gained the tendency (if the truck runs to one side) to run up on the fillet and guide itself away. The result has been a very decided decrease in flange wear, and that is one of the most serious sources of expense in the use of wheels—the rejections from flange wear. The tread is perfectly horizontal (or cylindrical) for 1 3-16-ins. outside, and from that point it passes off with a curve, which leaves the outside of the thread considerably easier and less projecting than in our present standard, which is a very good thing in going over frogs. These are minor points, but we feel that there is a good deal of money in them. We can very well see that after inspecting it; but the idea of enlarging the fillet here, so as to guide the flange away from the rail, instead of allowing it to run up against it, I think is a good idea, and the trains offer less resistance to the pull. The easing off at the outside has an important relation to frog wear and breakage of wheels.

In answer to these remarks Mr. Higgins stated that the tread of the M. C. B. wheel must necessarily be something of a compromise, from the fact

that different engineers have different ideas as to proper rail section; and the rail section used on the C., M. & St. P. Ry. might be one the chief engineer of another road would not use. For that reason he did not think the association could do anything else than propose a tread that may be considered as a compromise.

In sending us the print of the standard rail sections (60, 67 and 75 lbs. per yd.), Mr. D. J. Whittemore, M. Am. Soc. C. E., Chief Engineer


Full Contour Line indicates M.C.B. Wheel Tread.
Dotted Contour Line indicates C.M. & St.P.Ry Wheel Tread to Reduce Tendency of Flange Wear.
Rad.
Cylindrical
Tan. and Base Line of Curve
15°
ENG. NEWS.

SECTION OF WHEEL AND RAIL; CHICAGO, MILWAUKEE & ST. PAUL RY.

of the Chicago, Milwaukee & St. Paul Ry., stated that these were designed before the report of the rail committee of the American Society of Civil Engineers was promulgated, and had this report been issued sooner, it is exceedingly probable that the railway company would have adopted the Am. Soc. C. E. type of section, except in the item of top radius of the head. In the Am. Soc. C. E. sections this radius is 12 ins., but Mr. Whittemore prefers the 18-in. radius of the present rail, and it will be remembered that Mr. Whittemore has been a consistent advocate of flat-topped rails. The 75-lb. rail shown is 4¾ ins. high, with a base 4¾ ins. wide.

UTILIZING SPRINGS AS SOURCES OF WATER SUPPLIES FOR TOWNS.*

By Louis E. Hawes, C. E.

Exactly why a spring appears at any particular place is not always apparent or subject to conclusive demonstration without investigation on an elaborate and expensive scale. The most plausible and comprehensive reason that is usually given is that "the ground water in moving down a valley by the action of gravity encounters an obstruction or dam in its course which forces the water to the surface, where it appears as a spring." There are other well recognized and fully as important factors which may be mentioned as follows:

Differences in elevation between the absorbent or reservoir forming portion of the watershed and portions lower down, constituting the head; approach to the surface of the water-bearing strata or vein in which the water moves most rapidly, in consequence of the prominence of the bed rock or impervious strata below, or the rapid inclination of the surface above; the presence of boulders or ledge cropping at a location that is otherwise favorable, with the usual accompaniment of breaks and flurries in the stratification; and the perviousness of the overlying strata at a favorable point which offers little resistance to overcome the head.

As is very well known, the stratification of the glacial drift is decidedly varied and replete with abrupt changes, this is found to be particularly true where springs appear, so that in a consideration of the controlling influences little more than a statement of the general nature of the soil and a suggestion as to the main elements is possible without special data.

The relation of some of these factors in specific cases is shown by the accompanying diagrams which have been prepared from information gained through the aid of test wells and excavations in the regular course of practice, but without reference to its use for the present purpose. They represent the conditions in each place as closely as possible from the data available.

Fig. 1 is a longitudinal profile and section representing a portion of the upper part of the valley of Vine Brook in the town of Lexington, Mass. The watershed of the brook above the point marked C has an area of about ½ sq. mile, and above B, ¼ sq. mile. The valley has no well defined absorbent area of large extent above these points. The porous formation, of which there is a fair quantity, is distributed in small tracts on the main slopes and intervening undulations. Springs occur at the points marked A, B and C, and it is interesting to note their progressiveness as the area of the watershed increases, the one at A being an intermittent spring; the one at B, a small perennial, and the one at C a large perennial. Pervious material is represented as shown at D in the section, impervious as at E, muck as at F, and rock as at G.

The ground water in the valley above appears to be intercepted in its downward course by the impervious strata at E, causing it to find its way into the rock beneath, which is of a seamy, disintegrated nature, offering ample opportunity for the free passage of water and also permitting an outlet below at B, where the rock approaches nearest the surface and where the superimposed sand and gravel offers little resistance against the pressure that is acting upon the water.

The location of this spring appears to be determined also by a natural dam at H, some 1,300 ft. away, for the line of saturation between the two points is only slightly inclined, is practically at the surface, and but little below the elevation of the spring.

A marked feature of this profile is the succession of depressions containing muck deposits. The first one is 400 or 500 ft. long and 5 or 6 ft. deep; the second one about 1,000 ft. across and over 12 ft. in depth; while the third one is a half mile in extent and has a depth of 40 ft., or more. Geologists tell us that these depressions once formed ponds or lakes and that the muck has gradually grown until the basin has become entirely filled. Our observations and soundings show that this growth is in progress in many of the ponds, lakes and reservoirs now used for water supply purposes. Constant alluvium washings, debris, leaves, vegetable growths within the water and upon the bottom accumulate in the muck forming process that promises well for the ultimate conversion of the sheet of water into a meadow.

Fig. 2 is a sectional view at the location of the Porter Spring in the town of Avon, this state. The principal absorbent area is elevated from 15 to 50 ft. above the spring, is of considerable extent not far away, and the brook of the valley is about 450 ft. from the spring. The water issues at the point marked A in the figure and the principal factors determining the location appear to be the head or pressure and the interruption or determination of the strata carrying the water, which is occasioned by the impervious strata.

The water-bearing material is a coarse, reddish gravel 12 ft. below the surface, which disappears beyond the spring and is overlaid by a stratum of hardpan which also dips off a short distance away beneath the sand and gravel that follows. The bed rock is prominent, approaching within 16 ft. of the surface and dropping off below the spring, as in Fig. 1. As boulders occur in the upper strata, weak places were no doubt present which permitted the water under pressure to force its way through. It is significant regarding the head and usual tightness of the hardpan that when the well for utilizing the spring as a source of supply for the town was constructed, the walls were built up so as to store the water 3 ft. higher than before, whic was accomplished and the water in the well stood 5 ft. higher than the surface of the meadow 75 ft. away; the site of the original spring having been previously sealed over.

Fig. 3 represents the formation in the vicinity of the Colborn spring at Needham, Mass., which is an unusually large spring. Although hardpan and clayey material exists in parts of the watershed, the major portion is of sand and gravel formation of various degrees of porosity. The principal area suitable for ground storage is ½ to ¾ mile from the spring and elevated 50 to 70 ft. above it. As shown in Fig. 3 the spring appears at A, where the bed rock is prominent, approaching within 10 ft. of the surface, and a very large boulder or ledge cropping occurs a short distance above, which as found by excavations apparently disturbed the regularity of the stratification.

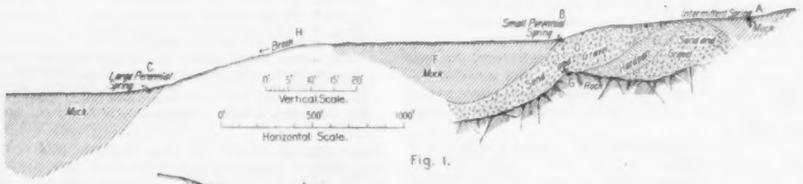


Fig. 1.

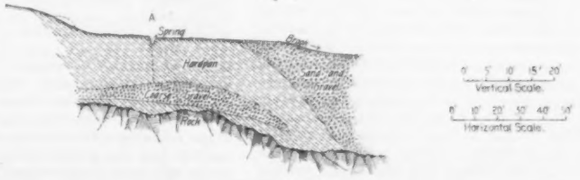


Fig. 2.

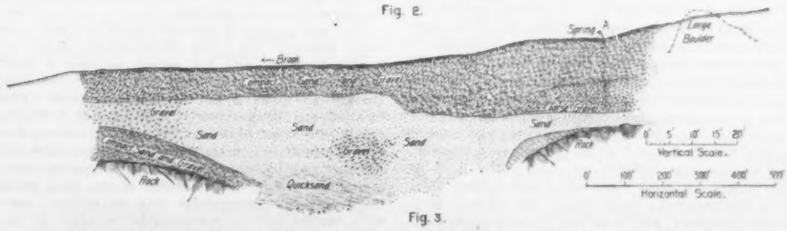


Fig. 3.

SECTIONS SHOWING THE STRATIFICATION AT SEVERAL SPRINGS IN MASSACHUSETTS.

Fig. 1.—Longitudinal Section Through Springs in Upper Part of Valley of Vine Brook, Lexington, Mass. Fig. 2.—Section Through Strata at Porter Spring, Avon, Mass. Fig. 3.—Section Showing Formation at Colborn Spring, Needham, Mass.

The water bearing material is 14 ft. below the surface, and consists of a mixture of coarse gravel and disintegrated rock or boulders, with a finer material of a somewhat similar nature above and sand beneath, while the surface strata is compact sand and gravel. Small pockets of sand and clay were found irregularly placed at the spring location. In the valley below a decided depression occurs in the sub-formation, which is filled with sand and gravel, varying from quicksand to fair-sized gravel.

*Condensed from a paper read before the annual meeting of the New England Water-Works Association, June, 1896. The paper will be published in full in the Journal of the New England Water-Works Association.

The main factors in this case are the compactness of the sand and gravel immediately below the spring, the diminution or termination of the coarse strata or vein and the great pressure from the storage reservoir, combined with the nearness of the water bearing strata to the surface and the presence of malformations. There are no indications of influencing obstructions further down the valley, the brook in a distance of 1,400 ft. having a gradual fall of 8.5 ft.

The supply well constructed at this place permitted the water to overflow at an elevation 2½ ft. higher than the average level of the original springs, and ¾-ft. above the bed of the brook adjoining.

Where springs have been taken by right of eminent domain and the damages for so doing determined in court, very interesting questions arise as to their capacity, permanence, possibility of contamination, the value of water, relative value of the spring in question, rights of the owner to the exclusive use of its waters and even questions affecting its genuineness, as in a case recently tried in the Superior Court for Norfolk Co., Mass.

As no two cases are alike, and this one has been settled, no harm can result in describing some of the salient features. The trial resulted from a suit for damages in the sum of $25,000 for the taking by the Commonwealth of Massachusetts of the Blue Hill Silver Spring in the town of Milton, which is located within the Blue Hills Park Reservation. In making an examination of the spring, its surroundings and watershed for the purpose of estimating its value, it was found to be situated upon the southerly side of Great Blue Hill. The watershed has comparatively steep slopes, largely composed of a stony, rocky formation, constituting a quick shed without favorable conditions for producing springs. The spring-well is 43 ft. from the brook draining the valley, is 3½ ft. in diameter and 5½ ft. deep. There is no overflow, but the water moving in the same channel that supplies it issues from the ground 40 ft. away as springs.

The conclusion was early reached that this water was from the surface, escaping from the brook somewhere above the spring-well and finding a channel through the rapidly inclining stony formation to appear below as springs. Measurements and tests were made to determine this, and it was found that at a point on the brook 400 ft. above the springs the quantity of water flowing in the brook equalled the quantity issuing from the springs below, plus the quantity flowing in the brook opposite the springs; showing that the brook lost an amount equal to the flow of the springs, somewhere between the places measured and probably at a comparatively flat portion of the brook just below the uppermost point.

These measurements, together with results of a corroborative nature from other tests, demonstrated that the spring water was simply brook water a little earlier in the day, and from the nature of the intervening formation subject to practically the same influences. However, both the brook water and the water from the well were excellent in quality at the time of the examination, and possibly more suitable for table use than many waters used for that purpose that come from permanent deep-seated springs.

In considering the possibility of utilizing a spring as a source of water supply for a town, the question of purity and freedom from possible future contamination having been settled satisfactorily, considerations of the size or flow of the spring, its permanence, seasonal variations, the area and nature of its watershed and its location and relation to other sources of supply naturally follow. To serve as the entire supply a spring must be of unusual size or the number of inhabitants to supply correspondingly small; when neither of these conditions is fulfilled except in a moderate degree, a spring favorably situated may be made a valuable adjunct to a supply from another source, either as an increase to the existing quantity or for the purpose of imparting an improvement to the quality, which is usually the result of such an admixture.

The number of springs that may be found in nearly every town in New England is almost surprising; no less than seven of fair size were examined by the writer in one town during preliminary investigations for a water supply, so that one almost invariably hears of certain springs that "never go dry," to use a common expression, that are suggested as suitable for public use. Most of them are either too small, isolated or unfavorably situated to be available for a town supply; but all have their enthusiastic admirers, and it is not to be wondered at, for with a spring are ever associated thoughts of an ideal drinking water.

When the possibility of having such water for every day domestic use becomes a reality, to draw it from a faucet like common river or pond water in a large city, and at an expense of less than 0.004 cts. per gallon instead of from 3 to 10 cts., as is paid for table water by the jug or carboy, it is a matter for congratulation, and the community possessing it is indeed fortunate.

The size or flow of a spring depends upon the area of the absorbent surface, the storage capacity in the ground, the head or resultant velocity of the flow, and the capacity of the channels through which the water passes, but it is always subject to direct variation with the rainfall. The main storage reservoir may be near or distant from the spring, but seldom or never surrounds it and is always above and usually at some distance away. The water reaches its outlet through the channel offering the least resistance, which may be a very porous strata, a particularly open portion of such strata, fissures in the rock or through the broken stone resulting from the disintegration of rocks and boulders. Where the water moves most rapidly in such channels it constitutes a vein, whose course may be very irregular and which is, therefore, often difficult or impossible to find from the surface.

The capacity of a spring in its normal condition can be readily ascertained by measuring its natural flow; if these measurements are continued at regular intervals over long periods of time, including seasons of extreme conditions, the seasonal variations will be determined. Such records are rarely kept, however, their importance seldom being realized until the spring is utilized and the normal conditions changed.

The capacity of a spring after its resources have been developed, or rather the capacity of the well or wells constructed for its development, differs materially from its normal capacity. The channel through which the water finds its way to any particular spring may be only one of the various outlets of the storage reservoir; the other outlets may appear at the surface as springs in other parts of the watershed of the stream draining the valley, or may continue underground in other courses to ponds and rivers below. Consequently, when the water is drawn down at any spring to a lower elevation than that at which it naturally appears, the head is increased, causing a corresponding increase in velocity of the inflowing water, which results in a greater discharge.

When the surface of the water is first lowered this increase in quantity may be partly ascribed to the amount stored in the immediate vicinity of the well; after a while this is exhausted, but the changes in inclination of the lines of saturation have become far-reaching and water, at the place under consideration, and estimate the quantity in accordance with the method described in Mr. Frederick P. Stearns' paper on "The Selections of Sources of Water Supply," under the heading "Quantity of Ground Water," printed in the "Journal" of the Association for March, 1892.

While it is possible that a spring-well as unevenly situated may not furnish as much water as a well located in open porous material with a direct watershed of the same area, it is very probable that it will furnish more water than could be expected from the same watershed in which it is located, were the spring and its supply channels absent.

Mr. J. T. Fanning, in his treatise on "Hydraulic and Water Supply Engineering," states that, "from springs, with the aid of capacious storage reservoirs, it might be possible to utilize 50% of the above (referring to accompanying table) volume of percolation. From wells, it would rarely be possible to utilize more than from 10 to 20% of the volume."

For the purpose of affording opportunity for comparison with other springs, the following data, compiled from observations made before and during construction and from the pumping records since, is given concerning two springs that have been utilized for town supplies six and five years respectively.

The Porter spring constitutes the present supply for the town of Avon, Mass., having a population of 1,626. The watershed of the brook draining the valley has an area above the location of the spring of about 0.5 sq. mile, with possibilities for a reserve supply; and the formation of a considerable portion of the territory is of a fairly absorbent nature, 30 or 40 acres tributary to the spring being especially favorable.

The table shows that during the last three years the quantity of water pumped exceeds the average natural flow as observed in 1889, demonstrating that the normal capacity of a spring is not the measure of the capacity of a well at the same location, the difference in quantity

TABLE I.—Yield in Gallons of Porter Spring, Avon, Mass., 1889 to 1895.

	1889.	1890.	1891.	1892.	1893.	1894.	1895.
Rainfall (Chestnut Hill reservoir), ins.	54.79	50.21	49.63	42.27	46.71	38.17	45.93
Daily average for the year	.....	12,982	39,945	41,168	55,124	59,728	61,921
Maximum pumping,[1] gallons per 24 hours	.....	27,752	44,484	82,807	81,455	101,313	77,945
Maximum for one day, gallons		77,589	84,811	120,045	122,974	143,970	135,551
Time pumping max. quantity, hrs. and min.	.....	2:30	2:30	3.25	.....[2]	4:40	.....[2]
Total gallons pumped during year		4,738,609	14,580,106	15,026,291	20,120,272	21,800,682	22,601,234

[1]Ten consecutive days. [2]While painting stand-pipe.

Note.—The yields given above are from the pumping records after beginning to utilze the springs. Observations of the natural flow in 1889, before beginning to pump, showed a natural flow in gallons per 24 hours, as follows: Minimum, 43,056; average, 49,680; maximum, 70,992; equivalent to 18,133,200 gallons per year. A 53-hour continuous test of pipe wells showed a yield at the rate of 243,000 gallons in 24 hours.

TABLE II.—Yield of Colburn Springs, Needham, Mass., 1890 to 1895.

	1890.	1891.	1892.	1893.	1894.	1895.
Rainfall (Chestnut Hill reservoir), ins.	50.21	49.63	42.27	46.71	38.17	45.93
Daily average, gallons per 24 hours	.....	25,419	64,654	106,149	112,217	139,099
Total gallons pumped during year	.....	9,278,008	23,663,503	38,744,726	40,950,255	50,771,384

Note.—The yields given above are from the pumping records after beginning to utilize the spring. Observations in 1890, before beginning to pump, showed a natural flow in gallons per 24 hours, as follows: Minimum, 246,818; average, 274,320; maximum, 310,532; equivalent to about 100,000,000 gallons for the year. Pumping continuously from the well excavation for 21½ days the yield in gallons per 24 hours was as follows: Minimum, 415,152; average, 440,479; maximum, 519,840.

water hitherto moving in other channels is diverted by the changed conditions and follows the new inclination. If the draft is continued the storage reservoir will be affected, its surface lowered or inclination changed and other outlets will lose a part or the whole of their flow, which is thereby contributed to the well being drawn upon. The latter condition was illustrated during continued pumping from the Needham well while in process of construction, with occasional interruptions. The flow of the Hicks spring half a mile away was diminished perceptibly and the action of the hydraulic ram affected, which was particularly noticed to occur when the pump at the well was in operation.

This spring is in a direction from the well nearly at right angles to the course of the brook. There are two brooks between, and the spring supplies a third and would naturally be considered in a different watershed, although the dividing line is not pronounced. From its location and the circumstance mentioned it is probably fed by the same reservoir. It does not follow, however, that the same or similar conditions always exist concerning any two springs that may be somewhat near each other, or even in the watershed of the same brook, for their particular watersheds may be distinct, separated by a barrier and uncommunicable, as might be the case with two springs on opposite sides of a wide valley.

The location of the Seaverns Spring in Lexington, Mass., is an example of the latter situation, being at the toe of the slope on the opposite side of the valley from the spring-wells and pumping station of the town supply, with a deep muck deposit intervening. No records have been kept that would determine beyond question that long continued pumping on the wells does not affect the flow of the spring, but from such observations as have been made it is probable that the spring is not seriously affected, if at all.

In a preliminary study of the probable quantity to be depended upon, it would be on the safe side to consider a spring-well supply, on the basis of an ordinary ground being made up from the storage reservoir. In 1894, the year of least rainfall, the quantity pumped was but 6% of the total rainfall, indicating that much water runs to waste during wet seasons.

The minimum natural flow was measured after a period of 19 days when the rainfall was so slight that probably none of it reached the water table; and the maximum, following a fall of 2.44 ins. These figures show the variations springs are subject to in direct consequence of variations in the rainfall.

The quantity pumped during a short preliminary trial of 53 hours was an aid in studying the source, and indicates pumping possibilities in a similar season when the storage reservoir has not been drawn upon for too long a period to permit of it, as does also the quantity pumped at a trial of the permanent pumping plant for determining its capacity per minute and steaming qualities, at which time 103,555 gallons were pumped into the stand-pipe in a run of 2 h. 43 min.

The Colburn spring supplies the town of Needham, Mass., which had a population by the 1895 census of 3,511. The brook nearby has a watershed above the spring of about 0.9 sq. mile, which is particularly adapted for absorbing a fair percentage of the rainfall. The yield of this spring is shown by Table II.

It is evident from the Needham records that the water required in 1895 was a little more than one-half the natural flow of the spring, and that the maximum demand has not required a draft upon the reserve in the main storage reservoir, 251,102 gallons being the maximum pumping for one day in 1894, the year of low rainfall.

The greatest natural flow observed in 1890 was on April 10, nearly 1 in. of rain having fallen the day before, and the least flow on Aug. 25, after nearly three months in which there was a deficiency of rainfall and in a season when it is doubtful if the water table received any replenishment.

The quantities pumped from the well excavation during construction are of interest, as the pumping occurred immediately after the deficiency in rainfall before mentioned and when little or no water was running in the brook above the spring. The pumping covered a space of 2½ months, and during three periods was continuous; one period of 11 days, one of 21.5 days, and the third of 12 days, with a dry spell of two weeks occurring during the longest period. The least quantity pumped was during three days at the end of the dry spell, and as given in the table was 415,152 gallons, which amount represents 20% of the average daily rainfall for the twelve months preceding.

By the third day after pumping ceased at the end of this space of 2½ months, during which time the quantity pumped and the natural flow exceeded 23,000,000 gallons, the spring had resumed nearly its usual flow.

The Colburn spring, originally consisting of three distinct springs, within a radius of 110 ft. of each other, is not far from the Charles River. This locality is near the middle of a long detour which the river makes about the town, almost semi-circular in shape for a distance of about nine miles. The town is practically enclosed by it on three sides, the main villages being situated near the center of the bow on elevated land about a mile from the river. The watershed of the brook is east of the villages and comprises a portion of the Needham Plains before referred to, with an absorbent area of a hundred acres or more where the formation is very porous and the water table 25 or 30 ft. below the surface.

The location of the works is particularly fortunate in possibilities for the future when the town outgrows the supply from the well; not the least of which is the opportunity to obtain a ground supply near the river; legislative right to a daily quantity of 500,000 gallons from it having been obtained by the town.

The supply works are designed with a view to future additions, the pumping station being located nearly midway between the spring and river. This renders the connection between pumps and well longer than ordinarily advisable for a direct suction. It was determined by considerations of the best location for the station, present and future, together with the fact that the extra friction in the suction pipe would be of little consequence in this case, as there is a back head of 2 ft. on the pump discharge valves when the well is full, and the maximum lift is but 19 ft. The suction pipe is 12 ins. in diameter, 970 ft. long and laid on a true grade.

The spring well is circular, 22 ft. in average diameter, 24 ft. deep, built of open-jointed rubble masonry, with a lining of brick laid in cement mortar, for the upper 18 ft., and is surmounted by a conical shingled roof. It was built at the largest and highest of the three springs, and the sites of the other two were sealed over by beds of concrete, while the water was kept down by pumping from the well. The outlet is 1½ ft. below the top of the well, which overflows between times of pumping.

The pumping plant is in a substantial brick building, is operated by steam, the machinery is duplicate throughout, designed for economical operation and has a total capacity of 1,500,000 gallons in 24 hours. The plant is connected with the distribution system ¾ mile away by a 10-in. force main.

PARIS TRAMWAYS, PAST AND PRESENT.

According to a report prepared by Mr. Graham, of the British Embassy at Paris, tramways were introduced into that city in 1853 by Mr. Alphonse Loubat, who had just returned from a trip to the United States and saw them tried in New York. They were at first called "Chemins de Fer Americains." On Aug. 16, 1853, a trial took place in Paris, which was fairly successful, and on Feb. 18, 1854, an imperial decree authorized M. Loubet to establish and operate horse-tramways between Sevres and Vincennes. In 1856 this right was transferred to the Compagnie Generale des Omnibus. The Loubet concession provided for the building of about 18 miles of line, of which 5 miles were not built until about 1874.

In 1893 the urban and extra-mural systems of Paris tramways extended over 230 miles, and they carried annually over 158,000,000 passengers. The city of Paris is not entitled to any portion of the receipts from these lines, except as covered in the following taxes and rents: A ground rent for offices, stations and shelters erected on the highways and a tax of 6 cts. on each car starting from a terminus within Paris. The city receives annually about $23,500 as rent for offices, etc. The State receives nothing from tramway enterprises; not even the 3% wheel-tax levied on ordinary carriages.

A decree of Aug. 6, 1881, fixes special conditions which tramway companies must comply with in the construction and operation of their lines. All plans must be approved by the Minister of Public Works and the Municipal Council, and these plans cannot be modified without the consent of these parties, though the administration may order such changes as will not give grounds for indemnity. The companies are answerable for the conditions of the highways over which the lines pass; and in cases of neglect the streets may be repaired by the city at the users' expense.

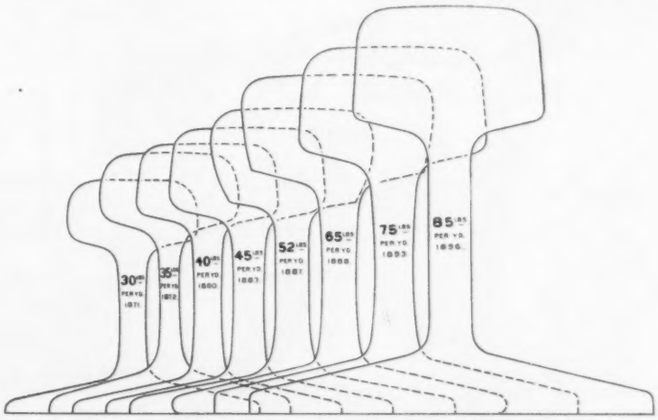
The maximum speed of steam tramways is fixed at 12½ miles per hour; and if there is danger to the public safety from any cause, the working of the line may be stopped or it may be given to a new company to operate. The city has the right to cross any tramway with roads, railways or canals without indemnity to the tramway company; and any concession for a tramway may be withdrawn at any moment if such a step is deemed to be of public benefit. The administration may grant concessions for new lines branching from the lines of old concessions without any indemnity to the original company. The two companies, in such a case, must come to an agreement regarding the use of each others' lines, stations, etc.; and in case of disagreement the decision of the Minister of Public Works is final. In the Department of the Seine control over the construction and operation of tramways is exercised by the Chief Engineer of the department, assisted by two engineers of the "Ponts et Chaussees," and one engineer of mines under the Prefect of the Seine and the Prefect of Police. The Chief Engineer is paid 3,000 francs, or $600, annually for these services, and his assistants are paid each 1,000 francs, or $200 annually—presumably in additions to other salaries.

The tariffs are fixed by the "Cahier des Charges" and must be approved by the Minister of Public Works for all state concessions, and by the prefect in all departmental or communal concessions. In Paris, the usual charges over the whole or any part of a line are 6 cts. for first-class and 3 cts. for second-class passengers. The first class have seats in the interior and are entitled to "correspondence," or transfers on any abutting or intersecting line having transfer offices; the second-class ride on top and have no rights of "correspondence" without an extra charge. Children under 4 years and bundles not exceeding 22 lbs. in weight are carried free. The administration may require, except on Sundays and national holidays, special cheap service for working classes with only second-class fares.

The lines are generally worked by horses, but mechanical power is making rapid progress. Ordinary and fireless steam locomotives, compressed air and electric motors are now used on several lines and the Belleville tramway is operated by a cable. The rails are of the American flange and Broca or Marsillon types.

RAIL SECTIONS OF THE DENVER & RIO GRANDE R. R.

The various forms of rail sections which have been used on any one railway of considerable age and length would make an interesting set for comparison, and we illustrate herewith a comparative set of the sections which have been used on the Denver & Rio Grande R. R. since 1871, when the construction of that road was commenced. There are eight sections, ranging from 30 to 85 lbs. per yd., and dating from 1871 to 1896, and these represent three different types of head. The first two (30 and 35 lbs. per yd.) have heads with round corners and sides, the second approximating somewhat to English sections. The next two (40 and 45 lbs. per yd.) have heads with outward flaring sides and very round corners. The next two (52 and 65 lbs. per yd.) have inward flaring heads, which is a distinctly objectionable form of section, and it will be noted that while the first of these (52 lbs. per yd.) has rounded sides to the head, the second (65 lbs. per yd.) has the sides very nearly plane. In the last two rails (75 and 85 lbs. per yd.) the section approximates to what is now practically the standard type of section, although the top corners of the head are of rather larger radius than is usually considered advisable.


30 lbs. PER YD. 1871
35 lbs. PER YD. 1872
40 lbs. PER YD. 1880
45 lbs. PER YD. 1887
52 lbs. PER YD. 1887
65 lbs. PER YD. 1888
75 lbs. PER YD. 1893
85 lbs. PER YD. 1896

COMPARATIVE SECTIONS OF RAILS USED ON THE DENVER & RIO GRANDE R. R. FROM 1871 TO 1896.

Our cut is reproduced from a page of the tenth annual report of the railway company, being for the year ending June 30, 1896. This report states that during the year 9,255 tons of rails were received and paid for, of which 5,266 tons are of the latest section, 85 lbs. per yd., as the management has deemed it prudent to increase the weight from 75 to 85 lbs. per yd. on these portions of the standard gage main line where the traffic of the system is concentrated and the speed of passenger trains is greatest. The heaviest rails used last year were laid north of Pueblo, Colo., and it is the intention, in the near future, to relay the balance of the 92 miles of single main track between Denver and Pueblo, with 85-lb. rails, provided the earnings permit of the expenditure. The relaying of the 28 miles of double track between these points will be deferred until a later time. The second-hand rails released by the laying of new ones are used upon other parts of the system to replace lighter rails now in use. Upon the standard gage main line between Denver and Grand Junction, 455 miles, and the Trinidad Branch, 91 miles, there are no rails of less than 65 lbs. per yd. carrying standard gage equipment. It is of interest to note that where the 85-lb. rails are used in the three-rail or mixed gage track, which extends from Denver to Leadville, 278 miles, the middle rail for the narrow gage (3-ft. gage) equipment weighs 65 lbs. per yd., making the total weight of steel rail 235 lbs. per yd. In an article on the Erie R. R., in our issue of Jan. 9, 1896, we referred to the use of 80-lb. and 74-lb. rails on opposite sides of the same track, but the Denver & Rio Grande R. R. goes even farther in using the above noted combination of an 85-lb. and a 65-lb. rail. It would be interesting to know whether this affects the riding quality of the track for the narrow gage trains.

WATER DEVELOPMENT ON THE MOJAVE RIVER, NEAR DAGGET, CAL.

By J. B. Lippincott.

The Mojave River rises on the northern slope of the Sierra Madre Mts. in San Bernardino Co., Cal. Its course is semicircular, flowing progres-

sively west, north and then east, and, as is common in the arid region, decreasing in volume as it progresses until the surface flow at last disappears in the sandy bed a short distance below Barstow.

The headwaters of this stream flow from elevations of 5,000 to 8,000 ft.; it sinks at an elevation of 1,900 ft., the foothills of these mountains being 3,000 ft. above the sea.

The basin may be classified in three parts:

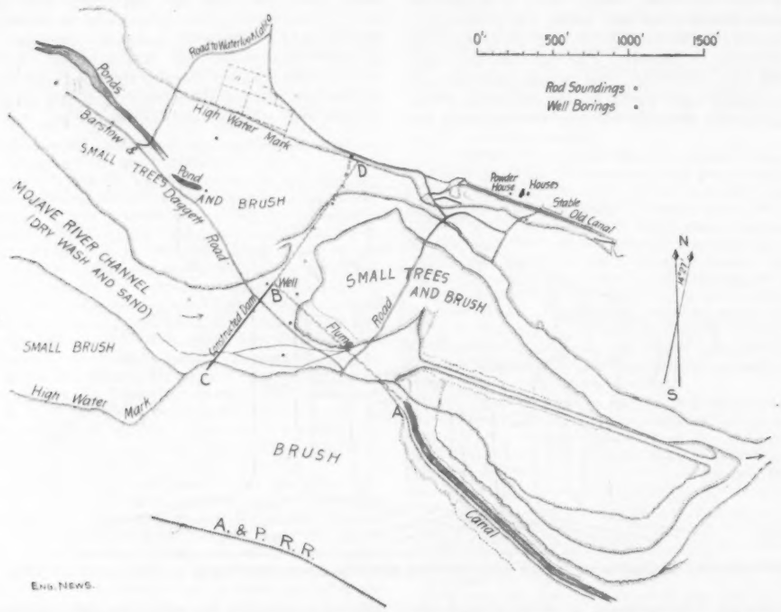


FIG. 1.—SUBMERGED DAM SITE ON THE MOJAVE RIVER NEAR DAGGETT, CAL., FOR THE IRRIGATION SYSTEM OF THE SOUTHERN CALIFORNIA IMPROVEMENT CO.

Mountainous, containing 251 sq. miles; foothills of 219 sq. miles; plains and desert buttes, 1,000 sq. miles; thus making a total drainage area above Dagget of 1,470 sq. miles. These areas were taken by a planimeter from the county map.

To the west there are many mountains that drain toward the Mojave desert, but the streams, which are small and few in number, disappear as soon as they reach the hot sands of the desert. The general slope of this great valley is toward the Mojave River from the west, at the rate of 2 ft. per mile, but the rainfall is so light, about 3 ins. per annum, and the summer heat so great that the runoff, to say the least, is not on the surface.

The rainfall on the coast ranges of Southern California increases with the elevation of the range on the side toward the sea until the summit is reached, the heaviest precipitation being just over the crest. This increase discontinues, however, above an elevation of from 6,000 to 7,000 ft., at a point not well determined. The rainfall at the heads of this river has been well measured by the Arrowhead Reservoir Co. Just north of the crest and in the basin of the Mojave River the rainfall is 60 ins., and from that maximum it falls rapidly to an average of 2.6 ins. per annum at Barstow. It will be remembered that the storms in southern California occur between October 1 and May 1, the greater portion of the rain falling during the months of December, January and February. They are frequently very violent and the fact that the ground is so dry, provided the storm is very severe, causes a greater flood. The rivers of the southwest attain a violence during these floods that is not readily comprehended until witnessed. Boulders of several feet in diameter are rolled along in the stream bed, producing a noise that may be heard for several miles.

In the mountains of this basin the rains are frequently very heavy, often falling on slopes that are both rugged and steep, thus yielding floods which being shot out from the hills far beyond the ordinary limit of surface flow into the desert, fill up the porous sand and gravel of the river bed as they progress, and from their very nature disappear as rapidly as they began. From 24 hours to a week thereafter will find the bed of the lower portions of the stream again dry at the surface.

This is the general character of the Mojave River. During the summer it flows in places, where the position of the canyon walls or of bed rock force the water to the surface, in a stream of 20 or 30 cu. ft. per sec., rising and sinking on its uncertain journey as it encounters impervious material and finally losing itself in the sand just below the headworks of the Southern California Improvement Co.

The floods that issue from the mountains carry themselves as far out into the plains as their sandy river beds will permit. In addition to these waters are those supplied to the stream perennially and which normally sink at the foothills. These percolate down the channel probably at the rates of from 5 to 20 miles a year, depending on the slope and the character of the voids in the stream bed. It is the water in the voids of the sand and that which percolates in the stream bed that the Southern California Improvement Co. endeavors to obtain.*

The determining fact in the selection of the point for the construction of the diversion works of the Southern California Improvement Co. was that the bed rock as an impervious stratum was found nearer the surface here than at any other place on the lower portion of the river, and although the river channel is broad and the valley extends in an unrestrained way to the south, from the surface channel, all things being considered, this was chosen as the most feasible place to put in the works of development.

The rock of this locality is favorable to the work. It is a pronounced porphyry and is found in every color. It disintegrates rapidly on exposure to the atmosphere and forms clays on its surface. The exposed rock in the hills is thus melting away into clays, being very soft on top and getting harder as it is penetrated. A foot from the surface the rock is usualy quite solid. As this condition obtains on the side hills next to the river, it is assumed that the clays that are found in much the same condition beneath the sands of the river bed are of the same nature and gradually merge into the porphyry rock, making an ideal condition for the stopping of the underflow of the river with sheet piles, which are here used. The piles are said to be driven from 1½ to 5 ft. into this clay, the latter being covered with a varying depth of river sand. The piling could not have been driven true in case large boulders had been found in the stream bed.

The method of procedure in the construction of this work was to start a canal far enough down in the valley below to permit the water that was developed to flow away from the works as it was encountered. At the point where the canal enters the river bed the conduit is changed into a carrying flume. This is shown as line A B on the map, Fig. 1. This flume is 5⅛ ft. in the clear; the top, sides and bottom are made tight to prevent any escape of the water which has been gathered above. In other respects it is constructed the same as the gathering flume which will be described below. This carrying flume passes through the sheet-piling and into what is called the "well." This is a junction bay into which it is the intention to have all the gathering flumes empty.

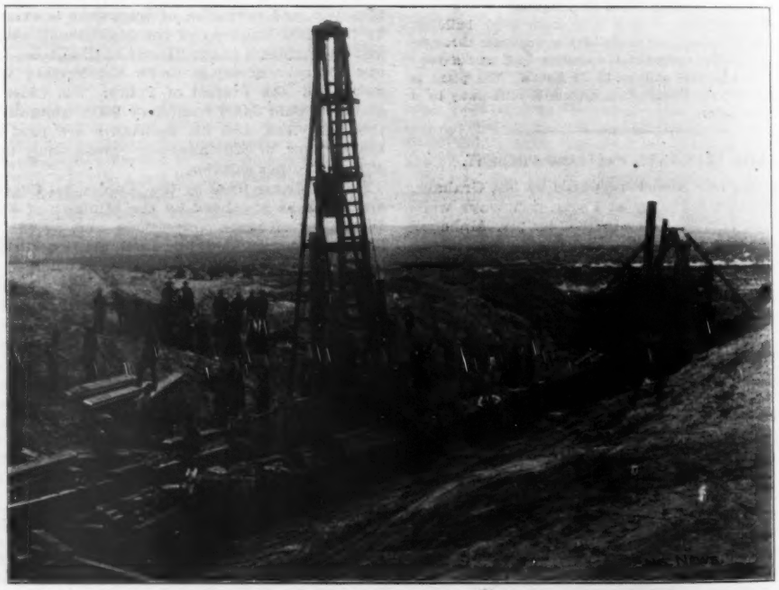


FIG. 2.—VIEW OF DAM AND COLLECTING GALLERY UNDER CONSTRUCTION.

The "well" is 10×6½×6½ ins., and is made of 6×8-in. timbers laid flat and bolted together. The bottom is drifted into piling, which are driven into the bed of the river for the purpose of form-

*As many of the conditions in connection with this work were personally investigated by the writer as was feasible, but much of it is of such a nature that this could not be done.

ing a foundation and anchor for the bay; the top is made of the same material, and two large trap doors open through it from above. These doors may be fastened down solidly to the rest of the frame. The top of the well is on the level with the top of the sheet-piling, and is 5 ft. below the bottom of the river bed. The trap door on the top of the well opens into a temporary shaft that extends above the surface of the ground and permits entrance into the flumes. This shaft is made of 2-in. plank and is set on the main well, but is not fastened, so that when the floods come they will roll the shaft away, and the doors of the well being closed the flood will pass over without encountering any obstruction.

The well being finished, the channel of the river was next opened along the line B C, Fig. 1, with scrapers, to a depth of about 10 ft., the water developed being permitted to pass out through the carrying flume. This scraper work having been excavated well down into the water-bearing gravels, the gates of the well were closed and the open channel allowed to fill with water. The dredger then floated into place and the excavation continued to the desired depth. It was then floated away and beached, and the gates of the well were opened, which by the drawing off of the water permits of the laying of the flume. This same order was followed in the laying of the carrying flume.

The gathering flume is first constructed and placed and then the sheet-piling driven below the flume (down stream), as show in the view, Fig. 2.

It is the intention to drive a row of piling on the line C B D, Fig. 1. These sheet piles are of the ordinary type, being 3-in. Oregon pine plank, 12 ins. wide, firmly bolted together, the lower end being sharpened to an edge. The lap of the plank is 3 ins., which permits the head being rounded to a diameter of 9 ins. These piles are driven with a 2,200-lb. hammer through the sand and gravel into the clay which is said to cover the top of the porphyry bed rock

Up to May 1, 1896, the piling had only been driven for about 600 ft. south from the junction bay or well at the center of the channel, as shown by the line B C, Fig. 1. They are sawed off at a depth of 5 ft. below the bed of the stream and below the level where the sand has become stratified. All of the flumes and piling are to be covered with sand, as finished. By this method it is the intention to offer absolutely no resistance to the stream when it is in flood, and in that particular the plan is most wise, for it has been found that in placing the slightest obstruction in a torrential stream bed that obstruction will be subjected to violent attack from both water and boulders. An excavation being made below the obstruction it will be thus undermined and knocked over.

The gathering flume is built from the well 700 ft. south. It is made of 3×12-in. Oregon pine plank, except on the top, where they are 4 instead of 3 ins. thick, to support the gravel above. It is built square, 5⅓ ft. in the clear, and in the manner in which timbers are framed for shafting, each being mortised into the other, and all being framed around 6×6-in. longitudinal timbers, which are set in the corners inside. A much more convenient form of flume for working purposes after construction, and with no more material in it, would have been 6⅓×4⅓ ft.

The bottom of the flume is first made upside down, the plank being nailed on the longitudinal piece, then floated into place and turned over. The sides and top are then built onto it. Openings of ⅝-in. width were left in the sides, and of 1⅛-in. in the bottom of the flume to admit the water. Four 4×8-in. sills were placed on the bottom of the cut for the flume to rest on. They were rammed well into the gravel and laid longitudinally.

Numerous water development tunnels have been built in southern California in water-bearing sands and gravels and have been lined by placing lagging on the top and sides on the caps and posts. These posts rest on substantial sills, but frequently no floors are put in them. These tunnels have been successful in obtaining water but they probably lose water by percolation where the grade gets above the water plane. In this case, where the sheet-piling brings the water plane constantly above the flume grade, it would seem that the gathering flume might have been dispensed with. As it is, one-tenth of the bottom is left open, and efforts have to be made to keep these openings clear. The intention of the design was to prevent sand entering the flume too freely and interfering with the flow in other parts. The action of the fine sand in the present case is to work into the openings in small quantities.

It has been found that driving the piling, after the flume was in place and only 2 ft. from it, has been the cause of jamming it out of line and driving the gravel tightly into the openings. In the remaining portions of the channel the piling will be driven as much as 25 ft. from the flume to avoid this undesirable result. The flumes are provided with gates so that they may be kept full of water to prevent rot.

The work of driving the sheet-piling across the river was less than half finished on May 1, the portion B D, Fig. 1, not being completed. It is fair to presume that when the channel is entirely closed to bed rock on either side of the river a greater amount of water will be obtained than a direct proportion of the present amount of water flowing to the portion of the river bed that is now shut off. At the present time there is approximately 7 sec.-ft. of water flowing from the carrying flume.

It is proposed to use this water on the Minneola Valley, which is a desert at the present time, but with the aid of water very favorable results may be obtained in an agricultural line. For the purpose of irrigation a charge of $22.50 per acre for the water right is made and an annual rental of $1.50. The duty of 1 cu. ft. per sec. to 250 acres is made. This is at the rate of $5,625 per sec.-ft. for the water right and $375 annual income from rentals.

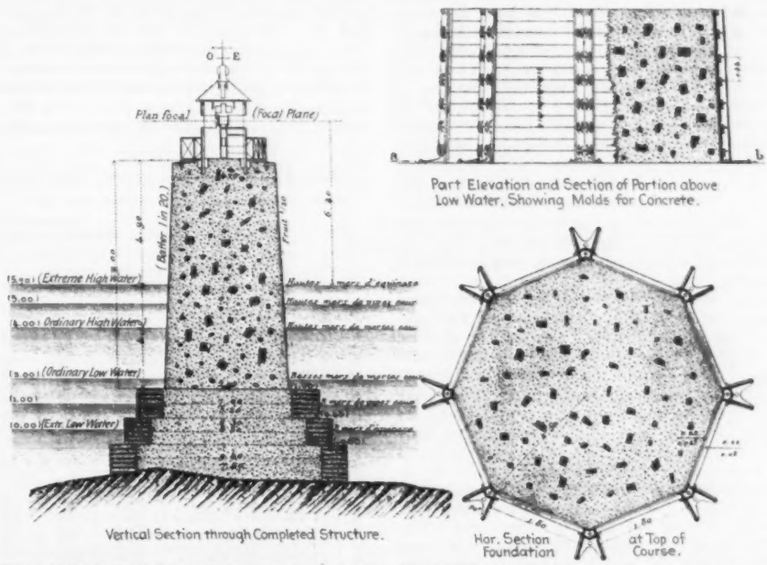
There are a large number of mines in this neighborhood, borax, iron, copper, silver and gold being found near here. These mines are paying at the rate of $11.50 a ton for coal. A drop of 100 ft. in the grade of the main canal has been planned for the purpose of developing power which will be offered to the mines and used for general purposes.

Mr. W. E. Robinson is general manager and vice-president of the Southern California Improvement Co. He designed these works and superintended their construction. The work has been well done and is a credit to his ability and energy.

A MONOLITHIC BEACON TOWER, FRANCE.

We illustrate herewith the beacon tower of Irvis-Pierres, at the entrance to the harbor of Lorient, on the coast of France. The execution of this work presented grave difficulties, owing to its exposed situation and the fact that the rock upon which it was to be founded lay about 6½ ft. below the level of the lowest tide, while the extreme rise of tide was 18.7 ft.

As built, the beacon proper is octagonal in form, with a base diameter of 16.4 ft. and a top diameter of 15.4 ft., 29.5 ft. above the base. The foundation was built in three courses, each presenting an offset of 2.8 ft., the total height of the base being 11.8 ft. The first part of the work consisted of clearing the surface of the rock from a heavy growth of seaweed; this was done by divers, and the roots and the finer mosses were then burned by breaking upon them carboys of hydrochloric acid and finally scrubbing the surface with steel brooms and fine wire brushes.


Plan (Focal Plane)
(Extreme High Water)
(Ordinary High Water)
(Ordinary Low Water)
(Extr. Low Water)
Vertical Section through Completed Structure.
Part Elevation and Section of Portion above Low Water, Showing Molds for Concrete.
Hor. Section at Top of Foundation
Course.

SECTIONS SHOWING THE CONSTRUCTION OF A SMALL CONCRETE LIGHTHOUSE AT TROIS PIERRES, FRANCE.

To define the exact position of the proposed beacon, and to guide the divers, a rectangular mast of wrought iron was fastened to the rock by wedges and spikes and bags of beton placed around the base. The center thus made was utilized in building a wall of bags of beton intended to contain the first layer of the concrete base; a light piece of wood attached to a ring encircling the mast was used to fix the position of the inside bags. It was found that the current was not strong enough to stop the divers from working and the state of the sea itself was the only obstacle, this latter depending on the direction and force of the wind.

When the wind was favorable a tug towed to the work a large barge and two smaller boats, containing all the material necessary for one day's work. The beton was made as it was needed, upon the barge, which was moored to four buoys located with the beacon-mast as a center. The beton was mixed during the passage of the plant from the little harbor of Lamar, and in building the encircling wall each sack of beton was lowered from a derrick on the barge in an iron bucket. The divers received this bucket and by opening the bottom deposited the sack in its place. The washing out of the cement was thus avoided. The sacks were made of a somewhat loose material which permitted their contents to unite closely together; and each empty sack made a rectangle of 4 × 5.2 ft., and 11 filled sacks made 1 cu. m. of wall. When this wall had reached a certain height it was filled with beton of the same character as that in the sacks themselves by dumping it from a cylindrical iron bucket with a bottom door.

The proportions for the beton to be used were only fixed after a special study. At high tide certain wooden boxes, 1 m. square on the sides and located near the experimental station at Lorient, were filled with beton. At the following low tide the sides of the boxes were demolished and it was then easy to watch the effect of the sea upon it. This experiment, continued during three months, convinced the engineers that a mixture of broken stone and a mortar rich in cement would give the

best results. Ramming the submerged beton was impossible, as this would have led to a complete separation of its elements by the action of the water. On the other hand, with broken stone as a constituent element of the beton, ramming is indispensable to obtain the intimate mixture of the stone and cement mortar. For this reason the first beton experimented with was generally lacking in compactness and impermeability. This difficulty was finally overcome by using material of small dimensions, or a gravel mixed with sand obtained from a beach near Lorient. The beton then adopted had a definite proportion of 500 kilos. (1,100 lbs.) of Portland cement to 1 cu. m. of the gravel; or, about 3 barrels of cement to 1 cu. yd. of gravel. This beton gave excellent results. The experimental blocks showed no interior voids and, thanks to the precautions taken in depositing it, there was no notable deposit of "milkiness" or "laitance" between the several beds. The mass was perfectly homogeneous throughout its height. The completion of the foundation courses required the three summers of 1891, 1892 and 1893, during which time only 54 days were available for actual work. The cost of the foundation work was 18,016 fr. ($3,603.20) for 195 cu. m.; this was equivalent to 84.60 fr. per cu. m., or about $13.00 per cu. yd.

The beacon tower itself was made of the same beton as the foundation, but the work was executed in the dry at low tides. As a matter of some slight economy, large stones were introduced into the beton, as shown in the illustration, the concrete being well rammed around them. The tower presents the form of a trunk of a pyramid with an octagonal base; a form fixed upon as most convenient for the arrangement of the molds to be used. The base is a regular octagon, 16.4 ft. in diameter, diminishing to 15.4 ft. at the top, which is 29.5 ft. above the foundation and about 16 ft. above the level of the highest equinoctial tides. Upon the upper platform of the tower is a fixed light, adapted to the use of mineral oil, placed in a lantern, 5 ft. 3 ins. in diameter, constituting a light of the fifth order.

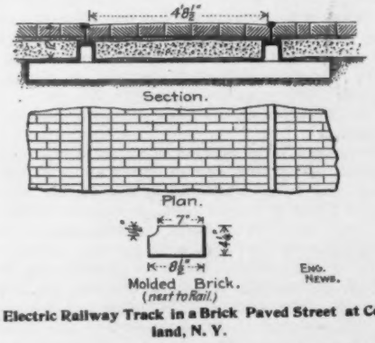
The molds used in building this tower were arranged as follows: At each corner of the octagon were placed special castings, the first or lowermost one securely anchored to the foundation, and successive sections were then bolted on as the work of filling progressed. These cast-iron sections had a uniform height of 2.44 ft. corresponding to two mold planks of 1.22 ft. each in width; the castings only weighed about 25 lbs. each, so they could be easily handled, and 3 bolts held them in place. The most delicate and important preliminary operation was the exact location of these castings at the eight corners of the tower. But when this was done the filling of the molds with beton was performed with the same bucket used in building the foundation and operated from a mast on the barge, and finally from a mast planted on the tower itself. The tower was built in the months of July, August, September and October of 1894; though in this period there were only 35 days available for effective work. The actual cost of this portion of the work was 3,570 fr. for material used, and 11,786 fr. for labor and all the accessory expenses of execution, including in this sum the original cleaning of the surface of the rock for the reception of the foundation. The tower contained 119 cu. m., and the item cost was 94.30 fr. per cu. m., or about $14.51 per cu. yd. As the foundation masonry, executed under water, cost only $13 per cu. yd., the cost of the tower seems high. But it must be remembered that in building the foundation the same quantity of beton was used each day, as the tides did not have to be considered. On the contrary, work on the tower was executed according to the stage of the tide, and in the beginning only one hour out of each tide was available for work. The workmen and the tug-service were paid for by the day and consequently the general expenses were constant. The total cost of the beacon tower was about 33,000 fr. or $6,600.

Since the completion of the work in October, 1894, the tower has been subjected to storms of exceptional violence. An examination made after two of these storms shows that the sacks of beton about the foundation are securely united together and none have been displaced; they preserve their original form in every detail. It is interesting to note that the foundation is already covered with a great quantity of small marine shells binding the sacks together and forming an excellent protection against the action of the sea.

The above description is prepared and our illustration is reproduced from a paper in the "Annales des Ponts et Chausees."

BRICK PAVING ALONG A STREET RAILWAY TRACK.

The city of Cortland, N. Y., is laying a large amount of brick paving this season. The accompanying cut gives a plan and cross-section of an electric railway track, showing the method specified for laying paving next to the rails and the bond adopted for the paving between the rails. It will be seen that the rail is supported on chairs in order to place the tie under the concrete and elevate the rail head to a level with the pavement. That street railway managers prefer the T-rail is well known, but it would seem that special brick forming a groove along the rail head would be better than the method here shown which breaks up the even surface of the street and leaves the inner side of the rail head as an obstruction to traffic. If the paving is laid in the way suggested, as is done in several cases, the T-rail is little more of an injury to the street surface than any form of grooved rail. In the light of



An Electric Railway Track in a Brick Paved Street at Cortland, N. Y.

these facts it would seem that the statutes and ordinances which have been enacted in various states and cities requiring the use of grooved head rails in the streets might well be reconsidered.

The work at Cortland is being carried out under the direction of Mr. Wm. B. Landreth, M. Am. Soc. C. E., as Engineer-in-Charge, and Mr. Walter L. Webb, Assoc. M. Am. Soc. C. E., as Assistant Engineer.

SIX TWIN-SCREW STEAMERS for the North German Lloyds' Steamship Co. have been launched at Stettin, Germany. Two of them are to be express steamers and four are intended for the regular passenger and freight service of the company between Bremen and New York. The dimensions are as follows: Length 525 ft. between perpendiculars, or 550 ft. over all; 60 ft. beam, 34 ft. deep, 10,000 tons register, and approximately 20,000 tons displacement, with a draught of 28 ft. The cargo space, including the steerage decks, shows a capacity of 11,000 cu. meters or 10,000 tons measurement. The cabins contain accommodations for 100 first-class and 76 second-class passengers, and 2,500 passengers can be carried on the steerage decks when not needed for cargo. The fore part of the steamer is provided with a turtle-back deck, 80 ft. in length, as a protection against the high seas of the Atlantic, and over the after part there is a poop 66 ft. long. Besides the double bottom, extending the whole length of the steamer, the vessels are divided by twelve transverse bulkheads, extending to the upper deck, into thirteen water-tight compartments. The motive power consists of two quadruple-expansion engines, which in three of the steamers will develop 7,000 I. HP. with a speed of 14 knots; while the others will have engines of 8,000 I. HP., resulting in a speed of 15 knots.

WEATHER TABLE FOR JULY, 1896. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation—rain or melted snow—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	67.0	91	45	46	7.9	30	NW	5.99	2.32	15
	Portland, Me.	68.0	92	52	40	6.5	26	NW	3.10	.76	15
	New York City.	73.4	89	59	30	11.8	50	NW	4.45	1.14	16
	Pittsburg, Pa.	73.8	93	53	40	5.7	25	NE	8.96	2.31	17
	Chicago, Ill.	72.2	93	56	37	14.9	36	NE	3.61	1 81	8
	Omaha, Neb.	74.6	96	56	40	7 0	30	NW	4.53	2.08	10
	St. Paul, Minn.	70.8	95	52	43	6 1	28	NW	1.12	.37	7
	Duluth, Minn.	66.5	89	47	42	7.8	34	NW	1 74	....	11
	Bismarck, N. Dak.	68 8	103	43	60	7.4	34	N	1.03	.42	8
	Average.	70.6	93	51	42	8.3	33		3.84		12
Southern Cities.	Washington, D. C.	76.7	94	56	38	5.5	26	NW	3.69	0.99	17
	Louisville, Ky.	78.4	98	59	39	7.7	45	W	13.01	5.50	11
	St Louis, Mo.	79.0	98	58	40	9.2	41	SW	4.67	1.80	13
	Savannah, Ga.	82.6	101	70	31	7.0	29	S	4.49	1.64	16
	Kansas City, Mo.	77.4	97	58	39	7.1	40	SW	8.66	5 62	8
	Jacksonville, Fla.	82 2	100	70	30	7 8	36	S	4.25	1.43	14
	Chattanooga, Tenn.	78.5	96	57	39	5.7	37	SW	5.80	....	15
	New Orleans, La.	82.8	96	70	26	6.8	35	SE	2.92	.94	12
	Memphis, Tenn.	82.4	101	63	38	8.5	26	SE	.80	.42	5
	Palestine, Tex.	83.4	97	67	30	6.0	22	NE	1.67	....	6
	Average.	80 3	98	63	35	7.1	34		5.00	....	12
Western Cities.	Helena, Mont.	68.6	95	44	51	6.8	35	SW	0.89	.43	7
	Port Angeles, Wash.	58.9	79	44	35	7.1	23	W	0.00	0.00	0
	San Francisco, Cal.	59 4	72	50	22	14.1	38	W	0.04	0.4	1
	Salt Lake City, Utah.	74 2	97	55	42	5.5	34	E	1.35	.58	8
	Santa Fe, N. Mex.	66.8	82	52	30	5 8	34	SW	3.78	.86	14
	Denver, Colo.	71.9	96	53	43	7.2	45	NW	2 80	....	12
	Yuma, Ariz.	91.3	110	68	42	6 9	33	NE	0.41	.33	2
	Average.	70.2	90.1	52	38	7·6	35		1.32	....	6

THE STRAIGHTENING OF A CHIMNEY STACK at the brick and tile works of the Standard Concrete Mfg. Co., Earnest, Pa., was recently accomplished under the supervison of Mr. B. W. Seamans, the company's superintendent. The stack is 122 ft. high, 11 ft. square at the base, tapering somewhat at the top, and weighs 400 tons. The walls are 36 ins. thick. The top was found to be leaning 45 ins. from a vertical line. To sink the side 4½ ins., 10½ ins. of brick work was removed from the foundation on three sides. As the bricks were removed square blocks of wood were inserted, one after the other, until three sides of the stack rested on the blocks. Between the blocks, supporting the stack temporarily, substantial brick piers 6 ins. high were built, leaving a space 4½ ins. between the top of the piers and the bottom of the undermined brickwork. The blocks were then set on fire and all were kept burning briskly. If one burned faster than the others the fire on that particular block was checked, so that all were made to burn uniformly, and as the blocks were being reduced to ashes the stack slowly righted. As the top gradually swung back through the 45-in. arc, small fissures appeared near the base. Into every crevice a steel wedge was driven, maintaining the solidity of the walls. The entire work consumed one day, and the reduction of the wooden blocks to ashes required an hour.

A 24-IN. GAGE RAILWAY is probably to be built as an experiment by the government of the colony of Victoria, Australia. The line will be from Wangaratta to Edi, 24-in. gage, laid with 20 or 24-lb. rails, with engines of about 80 HP., capable of hauling a load of 250 tons on the level, with a passenger car seating 30 passengers, the weight of the cars being 6 tons each.

A BOILER EXPLOSION occurred at a grist mill at Harrodsburg, Ky., Aug. 29, and several men were hurt and scalded.